FIG.1

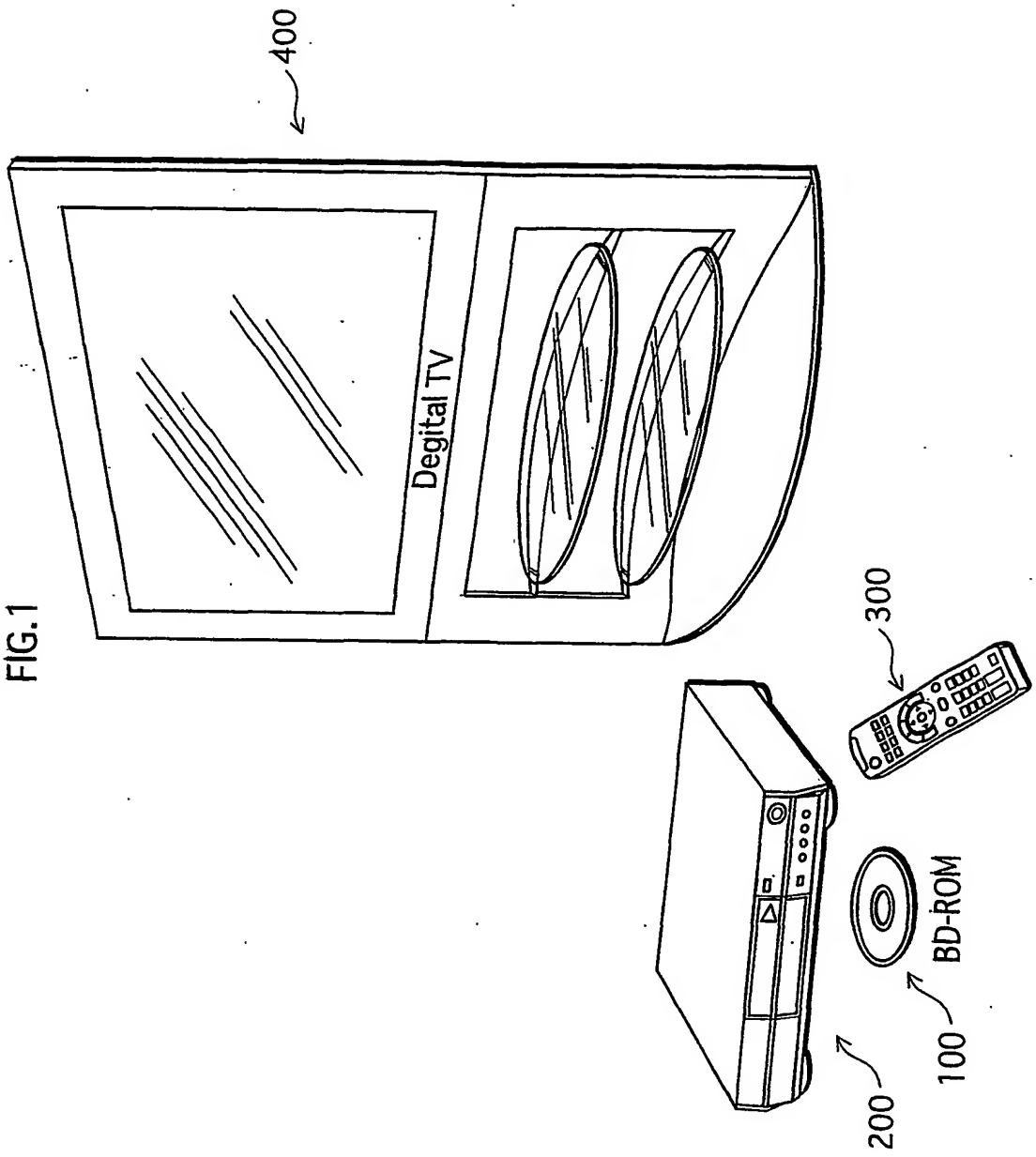


FIG.2

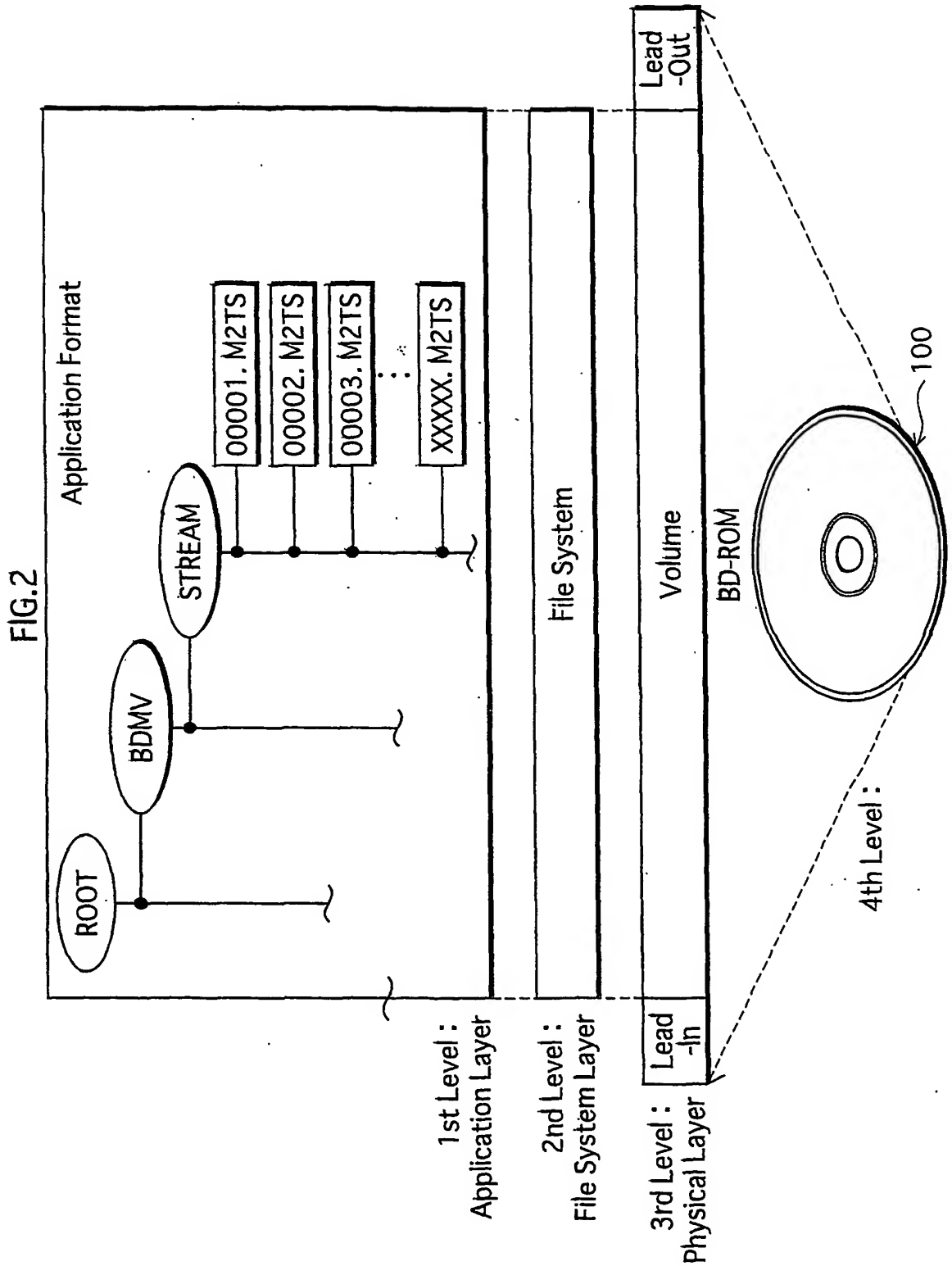
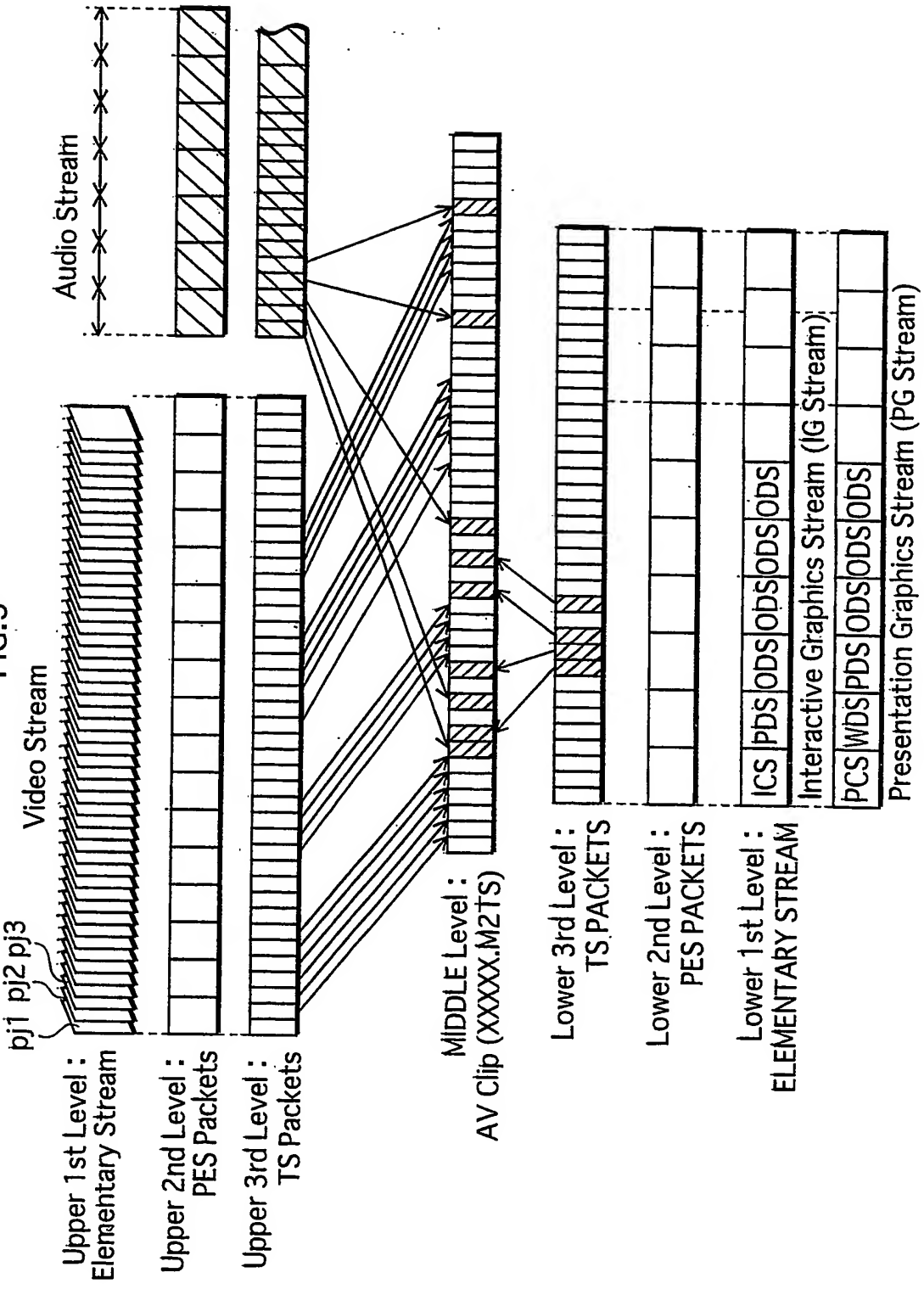

Application Format
ROOT
BDMV
STREAM
00001.M2TS
00002.M2TS
00003.M2TS
XXXX.M2TS
File System
Volume
Lead -In
Lead -Out
BD-ROM
100
1st Level : Application Layer
2nd Level : File System Layer
3rd Level : Physical Layer
4th Level :

FIG.3


Audio Stream
Video Stream
pj1 pj2 pj3
Upper 1st Level : Elementary Stream
Upper 2nd Level : PES Packets
Upper 3rd Level : TS Packets
MIDDLE Level : AV Clip (XXXX.M2TS)
Lower 3rd Level : TS PACKETS
Lower 2nd Level : PES PACKETS
Lower 1st Level : ELEMENTARY STREAM
ICS PDS ODS ODS ODS ODS
Interactive Graphics Stream (IG Stream)
PCS WDS PDS ODS ODS ODS
Presentation Graphics Stream (PG Stream)

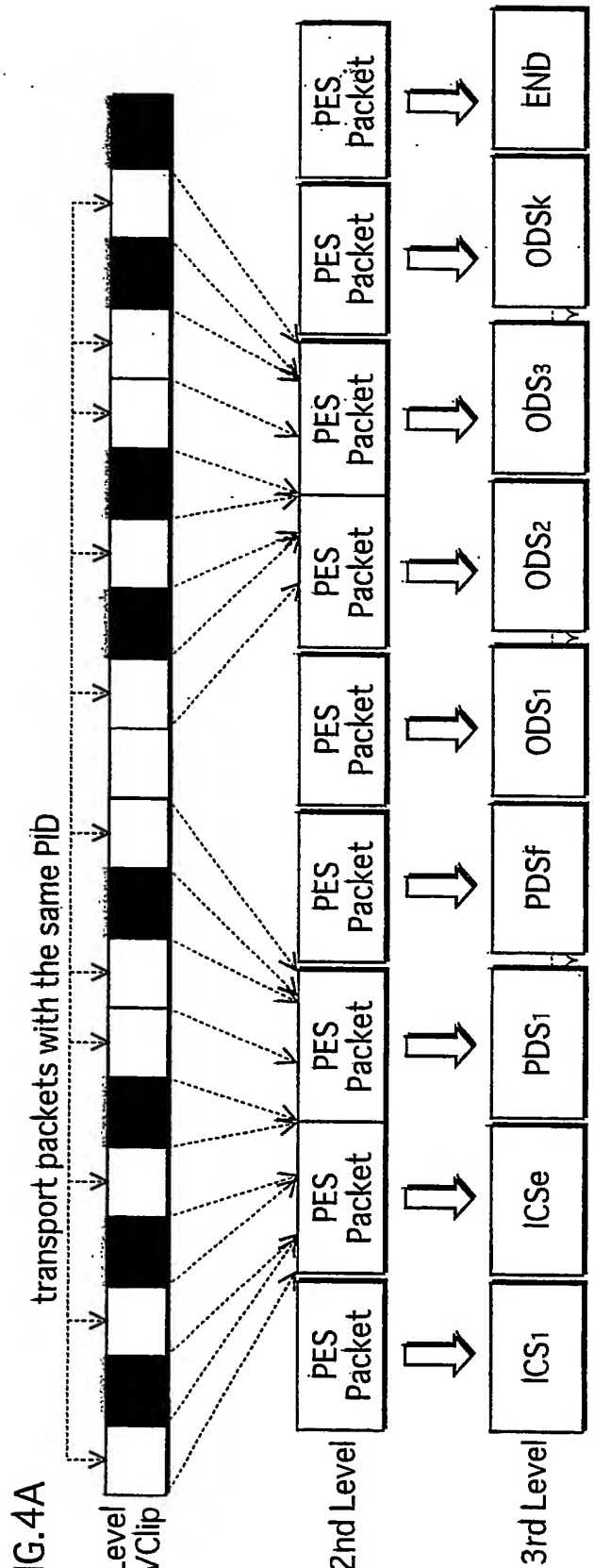

transport packets with the same PID
1st Level AVClip
2nd Level
3rd Level
PES Packet
ICS1
ICSe
PDS1
PDSf
ODS1
ODS2
ODS3
ODSk
END

FIG.4A

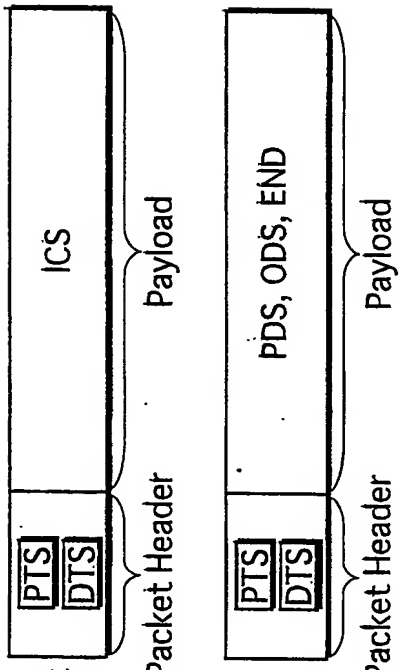
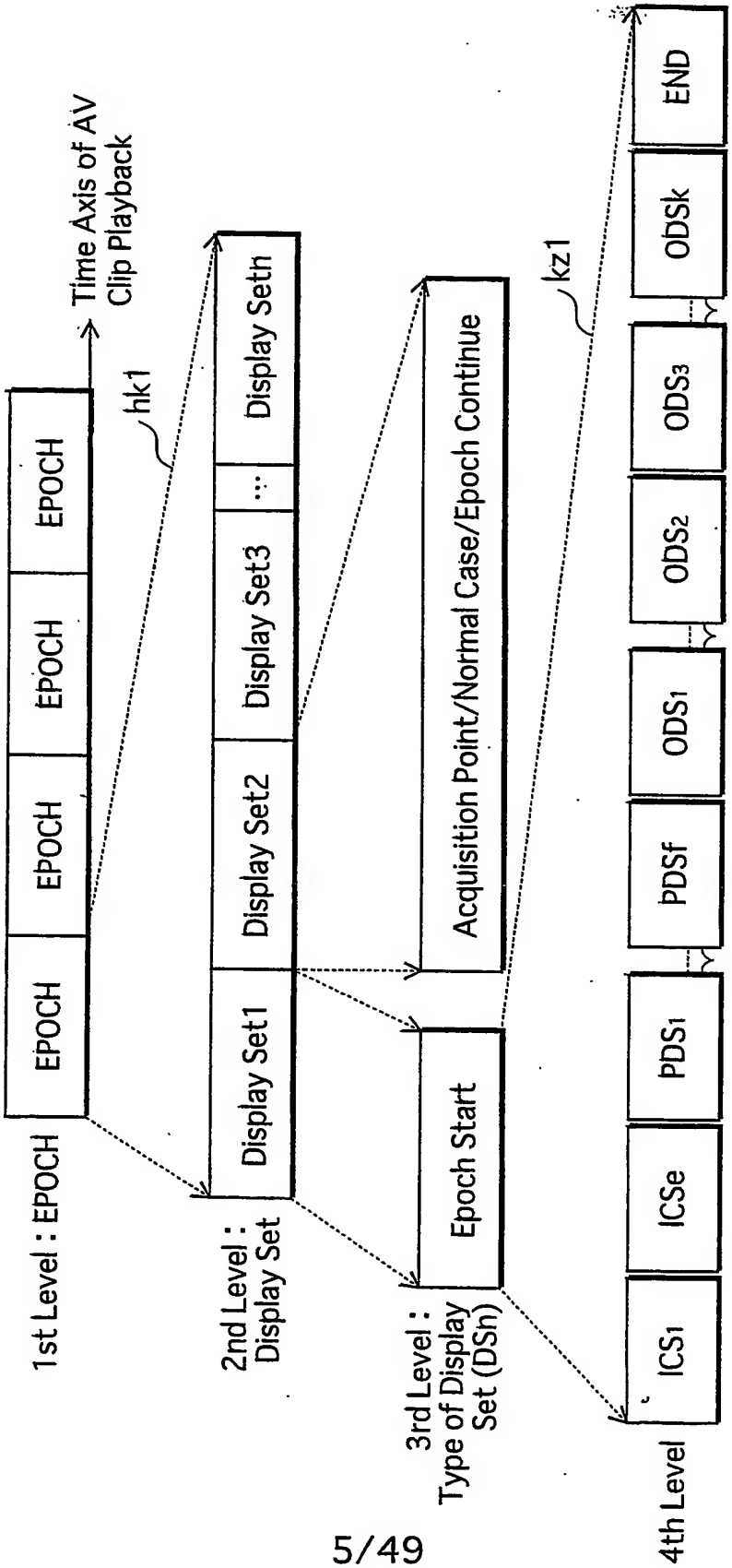

PES Packet
PTS
DTS
ICS
Payload
Packet Header
PES Packet
PTS
DTS
PDS, ODS, END
Payload
Packet Header

FIG.4B

FIG.5


Time Axis of AV Clip Playback
1st Level : EPOCH
2nd Level : Display Set
3rd Level : Type of Display Set (DSn)
4th Level
EPOCH
EPOCH
EPOCH
EPOCH
hk1
Display Set1
Display Set2
Display Set3
...
Display Seth
Epoch Start
Acquisition Point/Normal Case/Epoch Continue
kz1
ICS1
ICSe
PDS1
PDSf
ODS1
ODS2
ODS3
ODSk
END

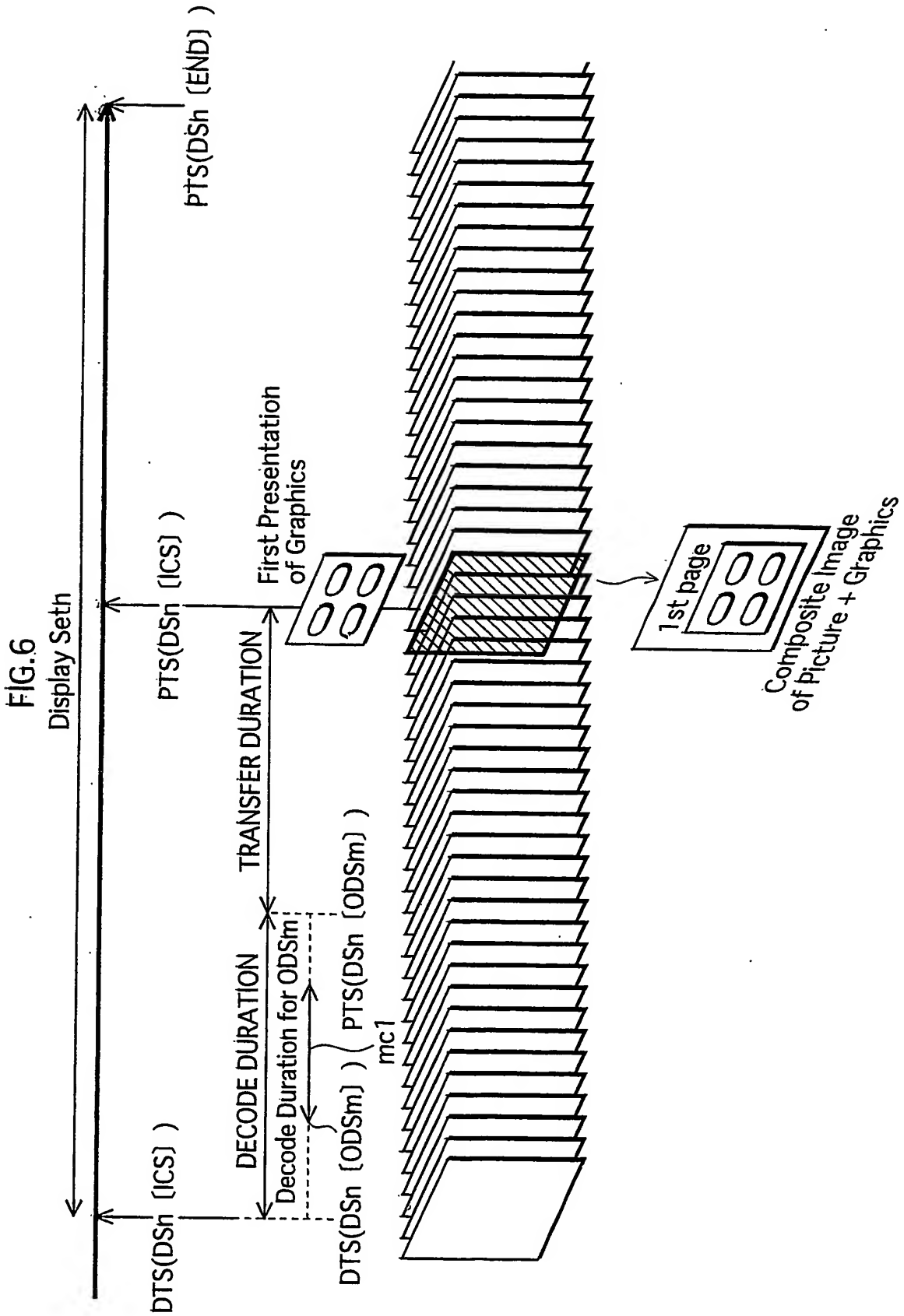

PTS(DSn (END))
PTS(DSn (ICS))
First Presentation of Graphics
Display Seth
TRANSFER DURATION
DECODE DURATION
Decode Duration for ODSm
DTS(DSn (ICS))
DTS(DSn (ODSm))
PTS(DSn (ODSm))
mc1
1st page
Composite Image of Picture + Graphics

FIG.6

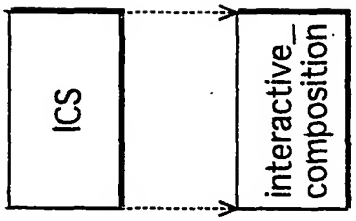

One-to-One Correspondence
ICS
interactive_composition

FIG.7A

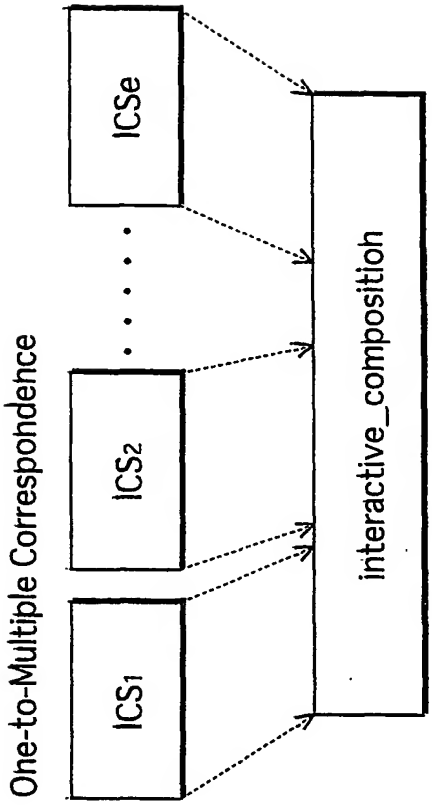

One-to-Multiple Correspondence
ICS1
ICS2
ICSe
interactive_composition

FIG.7B

FIG.8

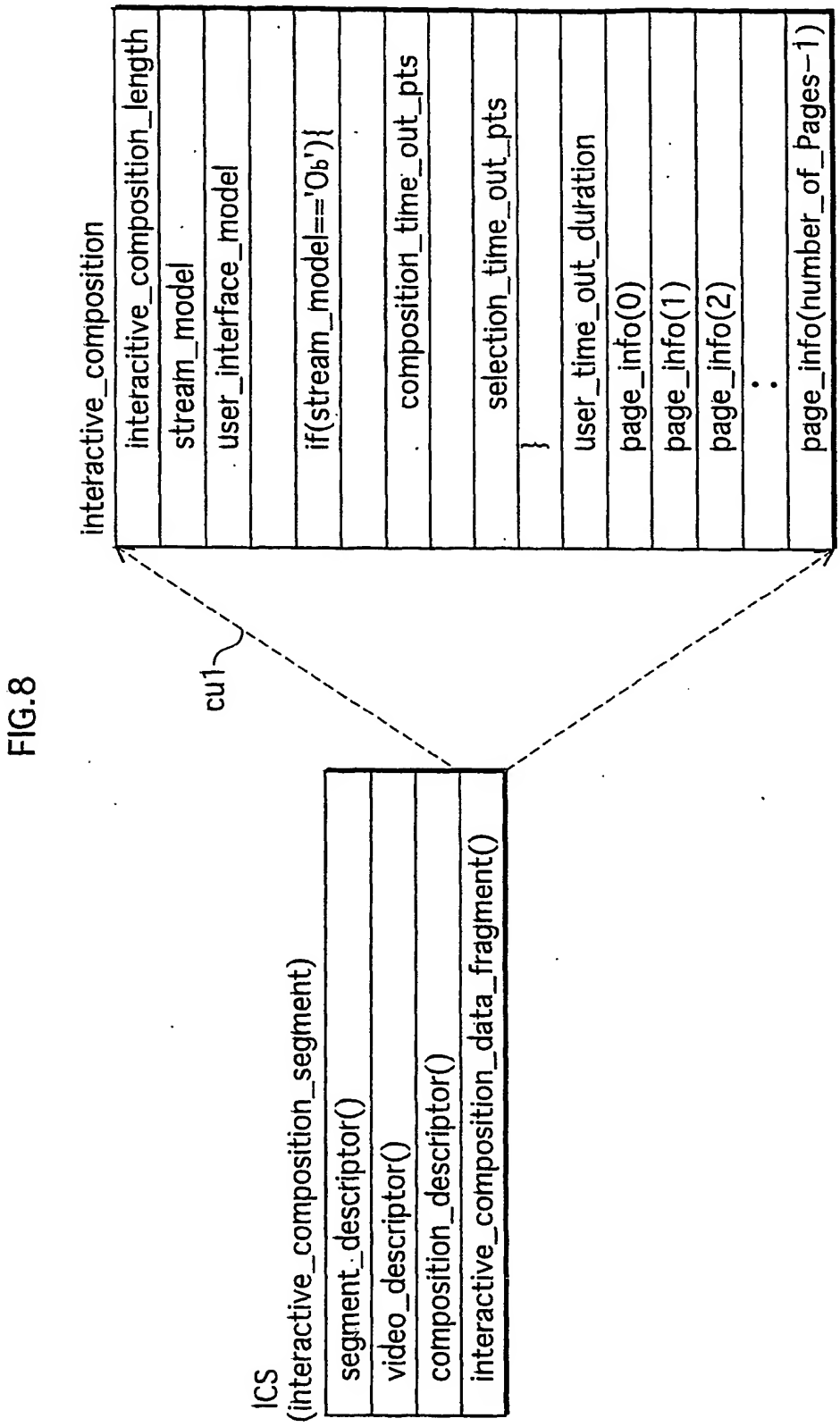

ICS
(interactive_composition_segment)
segment_descriptor()
video_descriptor()
composition_descriptor()
interactive_composition_data_fragment()
cu1
interactive_composition
interacitive_composition_length
stream_model
user_interface_model
if(stream_model=='0b'){
composition_time_out_pts
selection_time_out_pts
}
user_time_out_duration
page_info(0)
page_info(1)
page_info(2)
page_info(number_of_Pages-1)

FIG.9

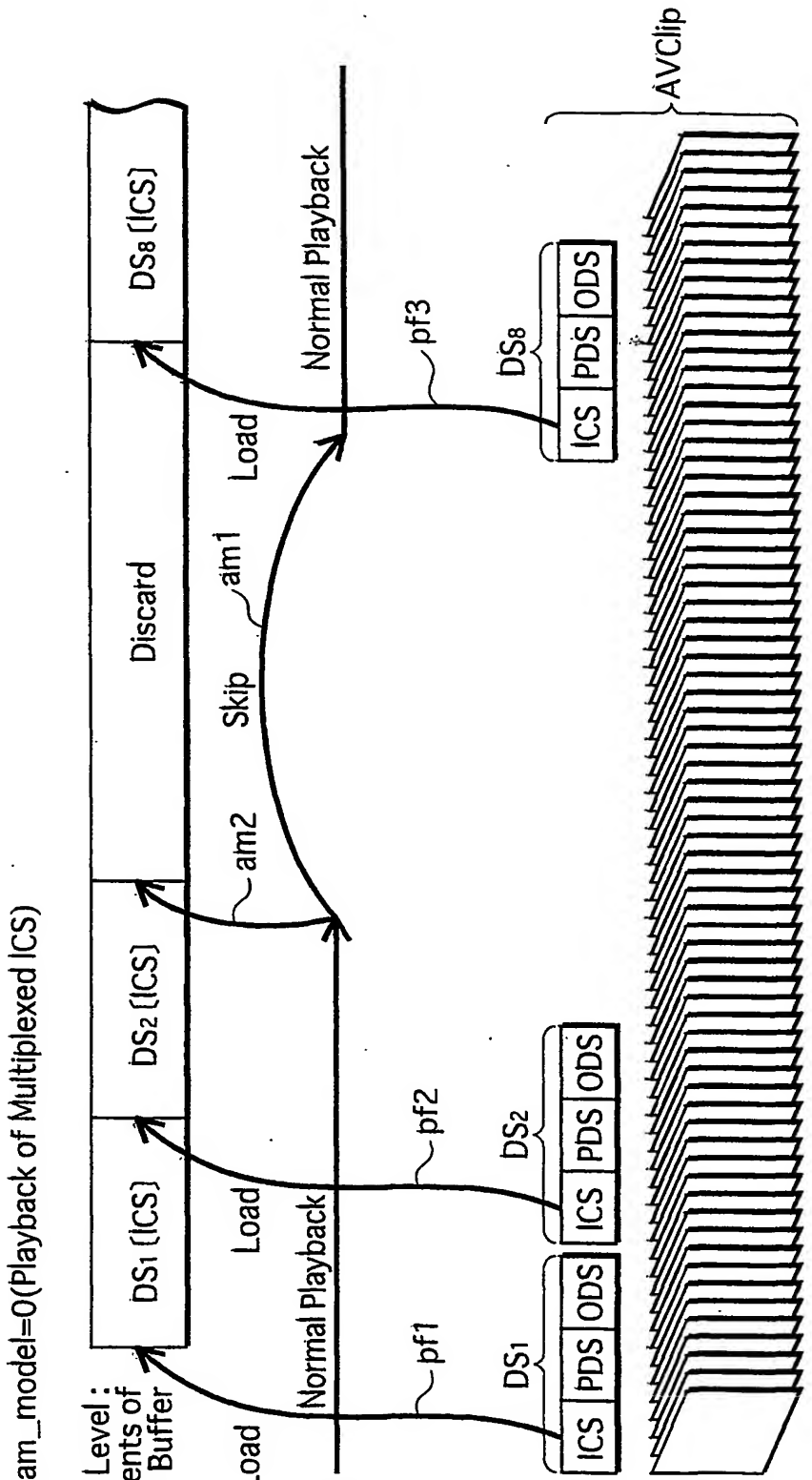

ICS.Stream_model=0(Playback of Multiplexed ICS)
1st Level : Contents of Composition Buffer
2nd Level : AV Clip Playback
3rd Level : Multiplexed Graphics Stream
4th Level : Video Stream
DS1 (ICS)
DS2 (ICS)
Discard
DS8 (ICS)
Load
Normal Playback
Skip
am1
am2
pf1
pf2
pf3
DS1
DS2
DS8
ICS
PDS
ODS
AVClip

FIG.10

ICS.Stream_model=1(Playback of Preloaded ICS)

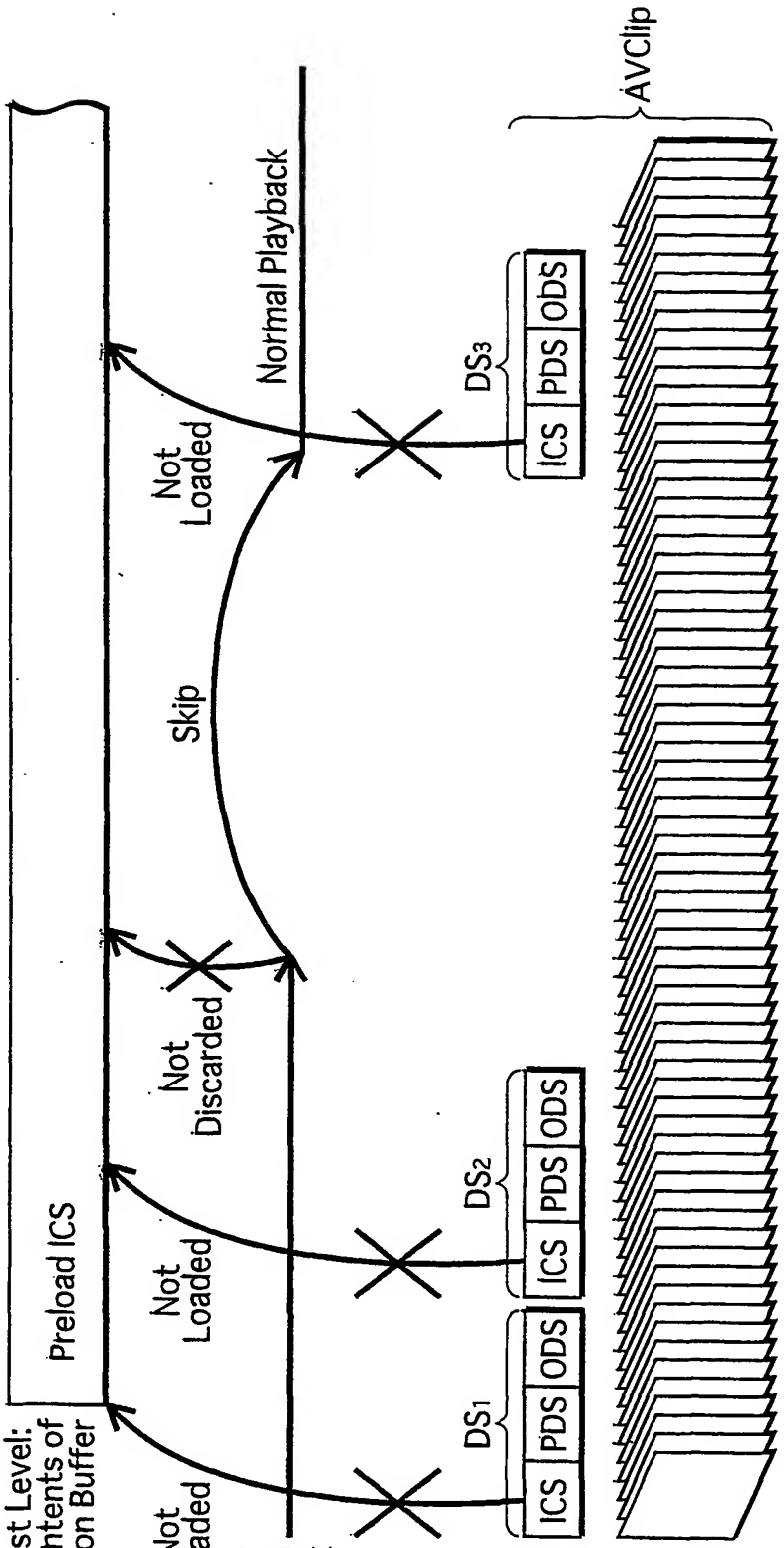
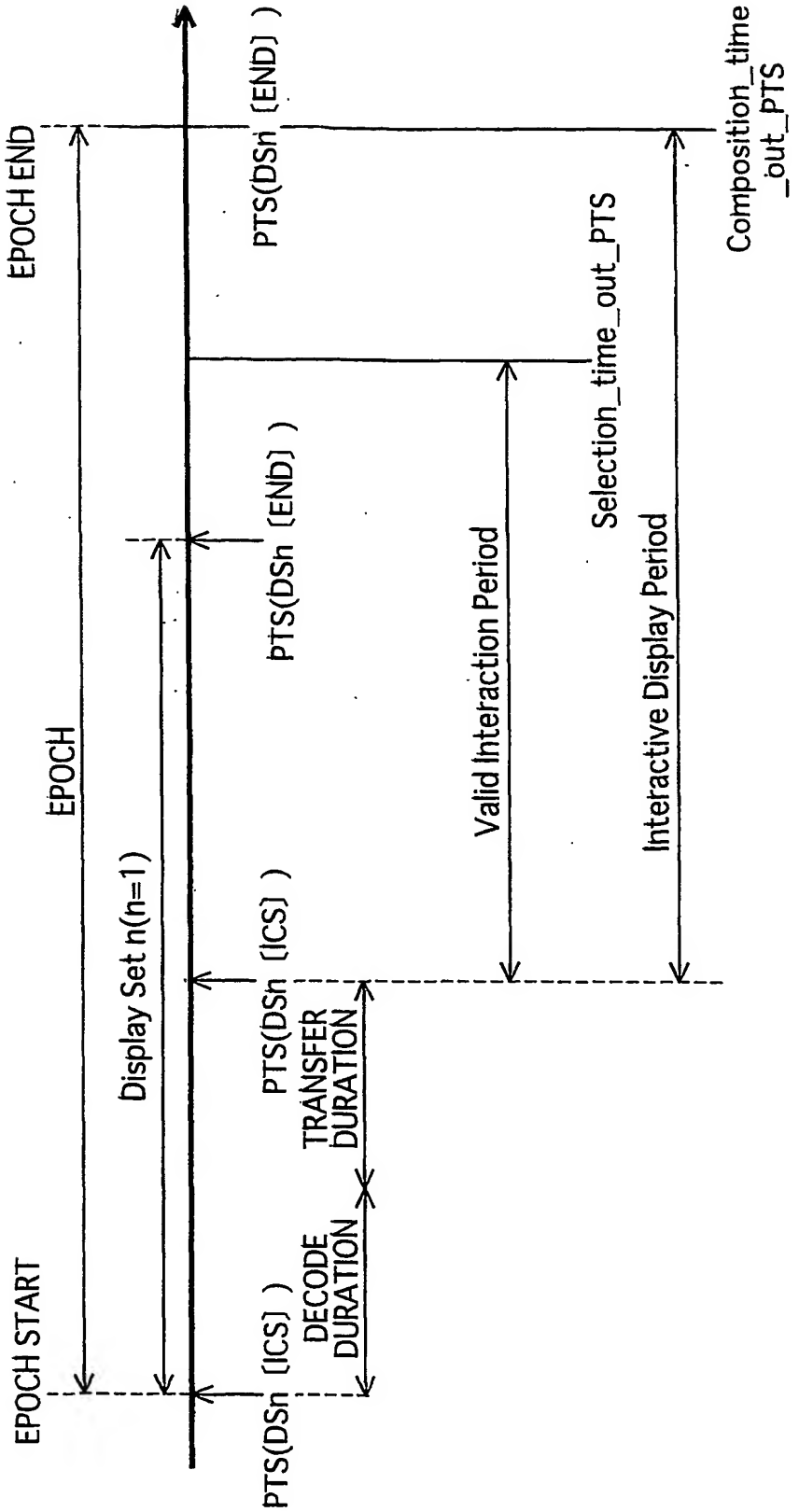


FIG.11


EPOCH END
EPOCH
EPOCH START
Display Set n(n=1)
PTS(DSn (END))
PTS(DSn (END))
PTS(DSn (ICS))
PTS(DSn (ICS))
TRANSFER DURATION
DECODE DURATION
Valid Interaction Period
Selection_time_out_PTS
Interactive Display Period
Composition_time_out_PTS

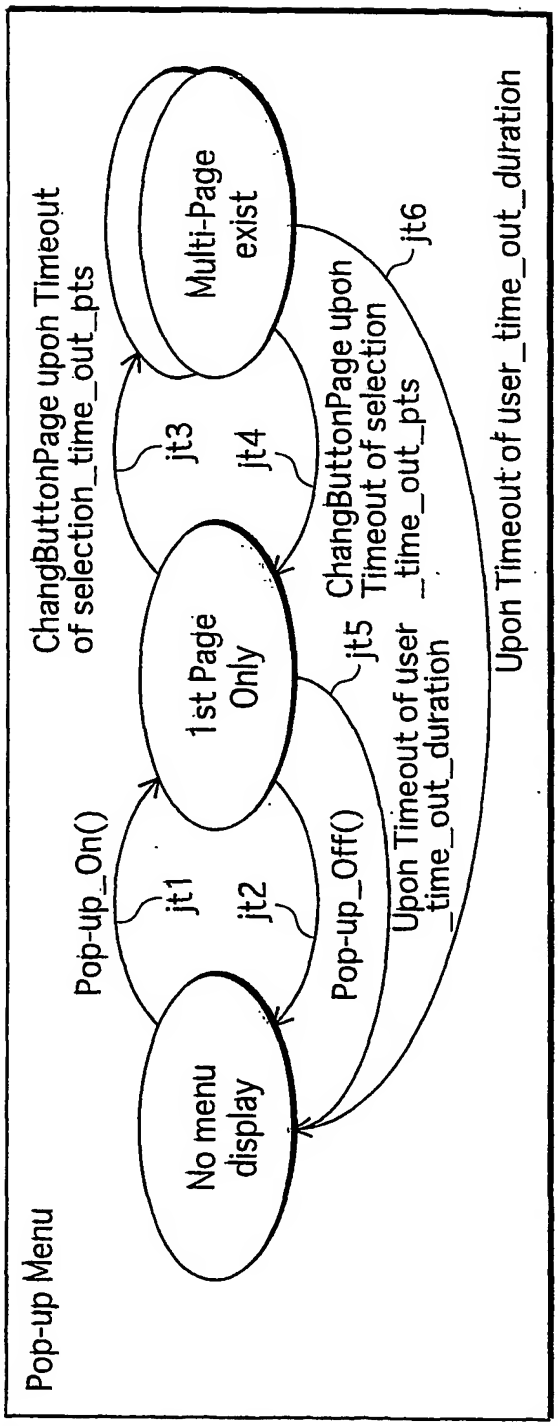


FIG.12A

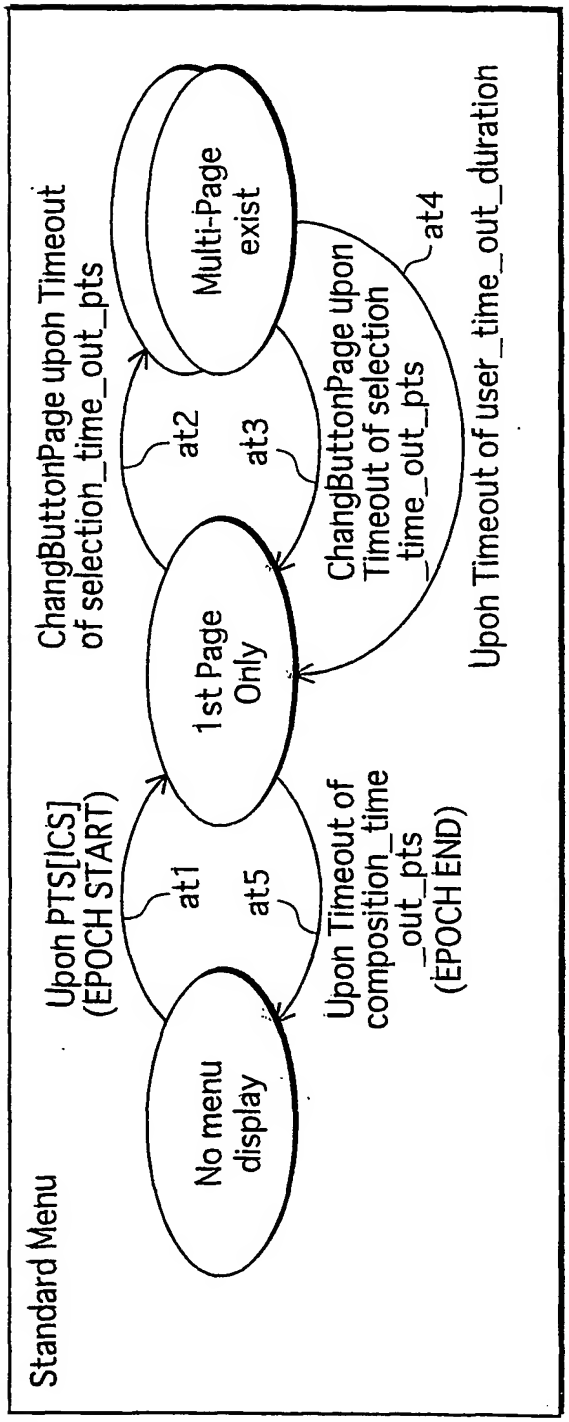


FIG.12B

FIG.13

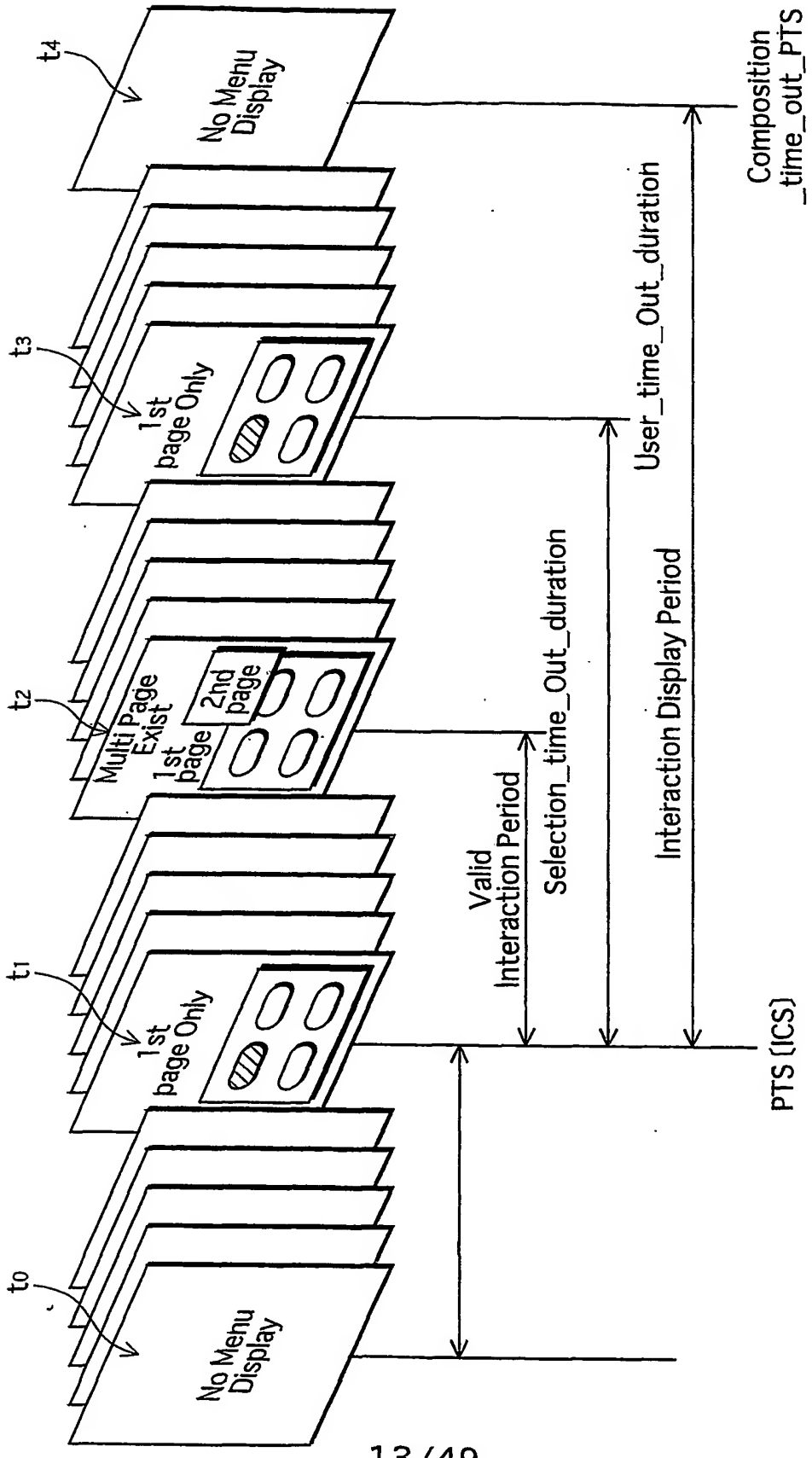

t4
No Menu Display
t3
1st page Only
t2
Multi Page Exist
1st page
2nd page
t1
1st page Only
t0
No Menu Display
Composition _time_out_PTS
User_time_Out_duration
Selection_time_Out_duration
Valid Interaction Period
Interaction Display Period
PTS (ICS)

FIG.14A

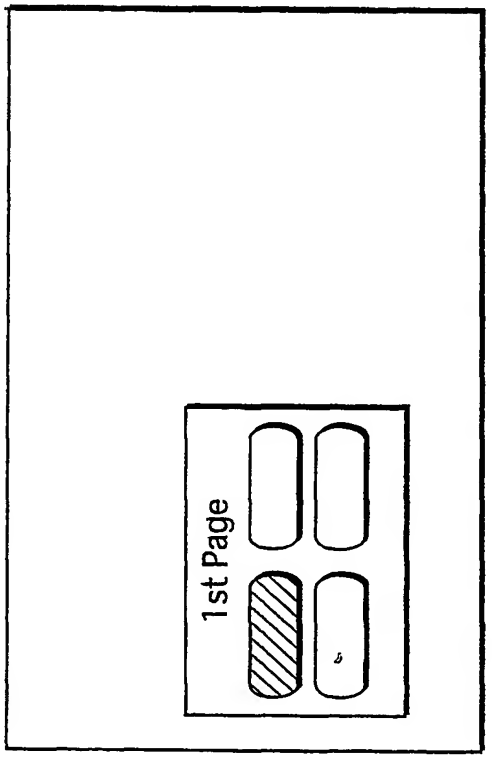


FIG.14B

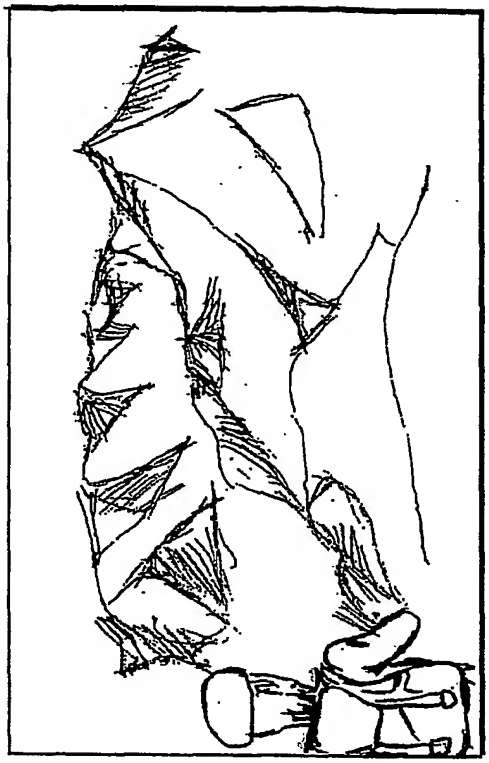
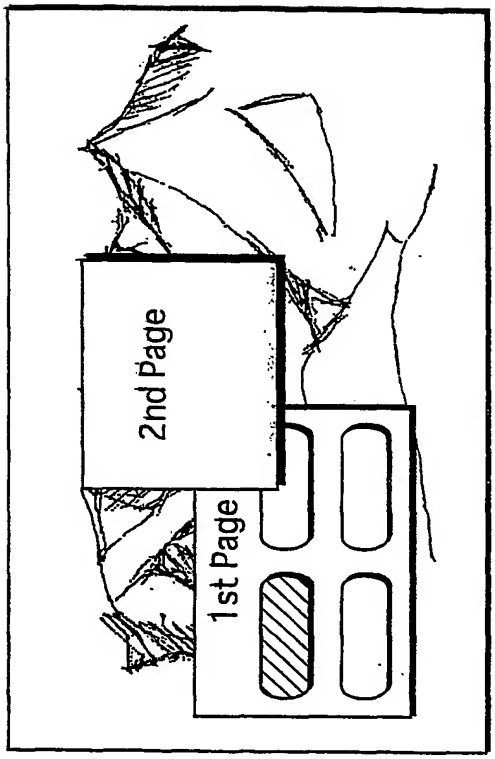


FIG.14C



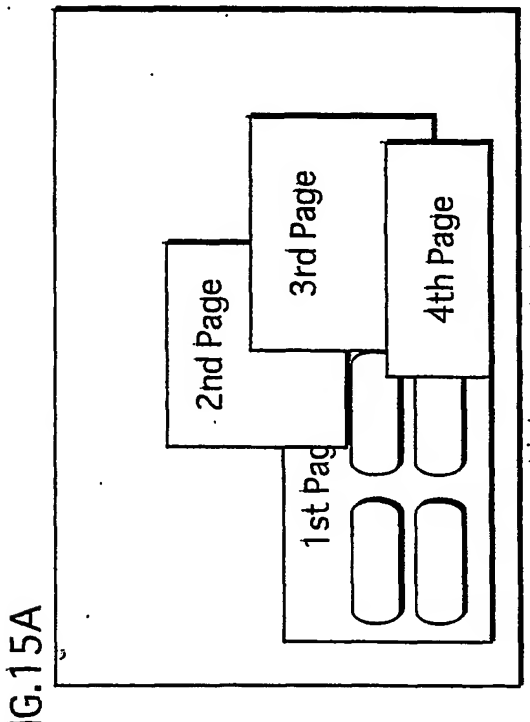


FIG.15A

FIG.15B

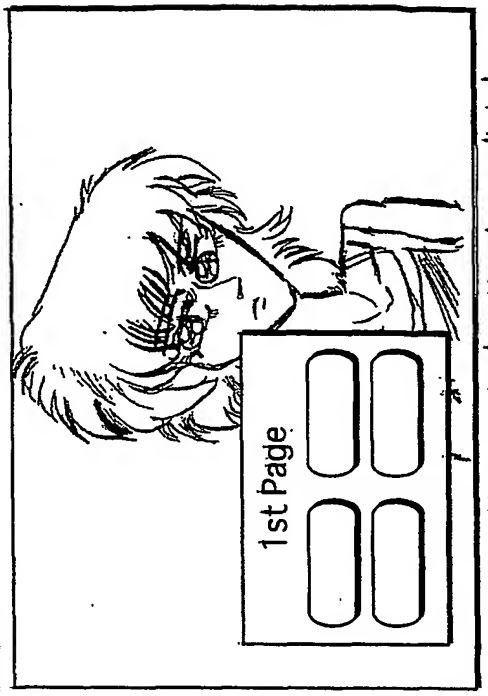


FIG.15D

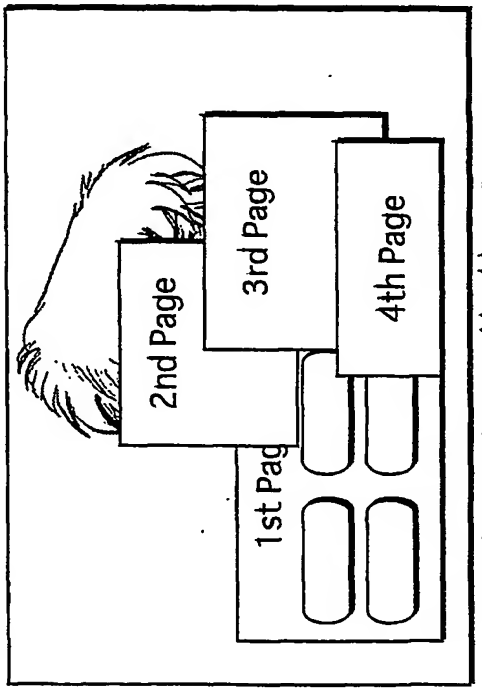


FIG.15C

FIG.16

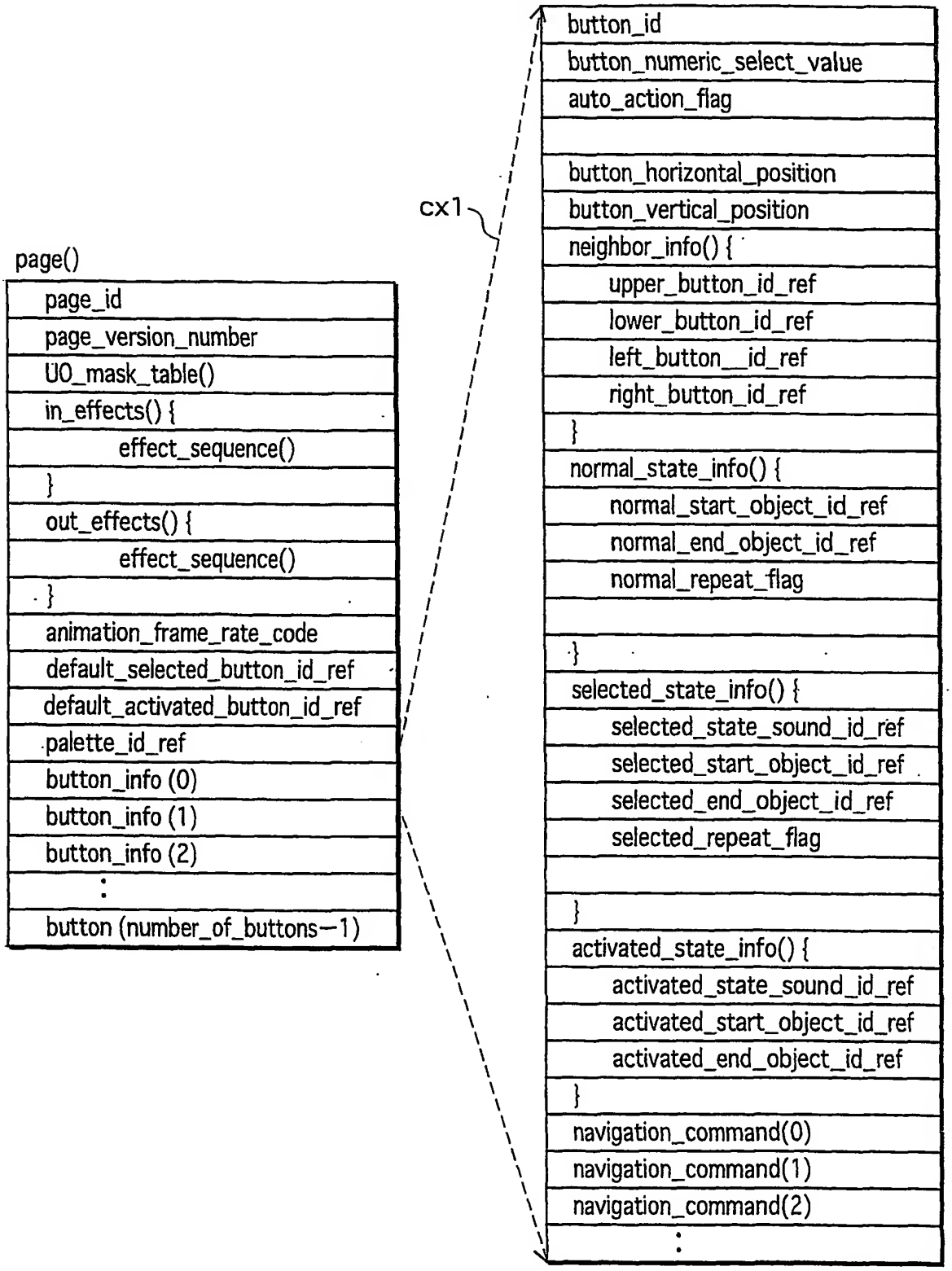

page()
page_id
page_version_number
UO_mask_table()
in_effects() {
effect_sequence()
}
out_effects() {
effect_sequence()
}
animation_frame_rate_code
default_selected_button_id_ref
default_activated_button_id_ref
palette_id_ref
button_info (0)
button_info (1)
button_info (2)
:
button (number_of_buttons−1)
cx1
button_id
button_numeric_select_value
auto_action_flag
button_horizontal_position
button_vertical_position
neighbor_info() {
upper_button_id_ref
lower_button_id_ref
left_button__id_ref
right_button_id_ref
}
normal_state_info() {
normal_start_object_id_ref
normal_end_object_id_ref
normal_repeat_flag
}
selected_state_info() {
selected_state_sound_id_ref
selected_start_object_id_ref
selected_end_object_id_ref
selected_repeat_flag
}
activated_state_info() {
activated_state_sound_id_ref
activated_start_object_id_ref
activated_end_object_id_ref
}
navigation_command(0)
navigation_command(1)
navigation_command(2)
:

FIG.17

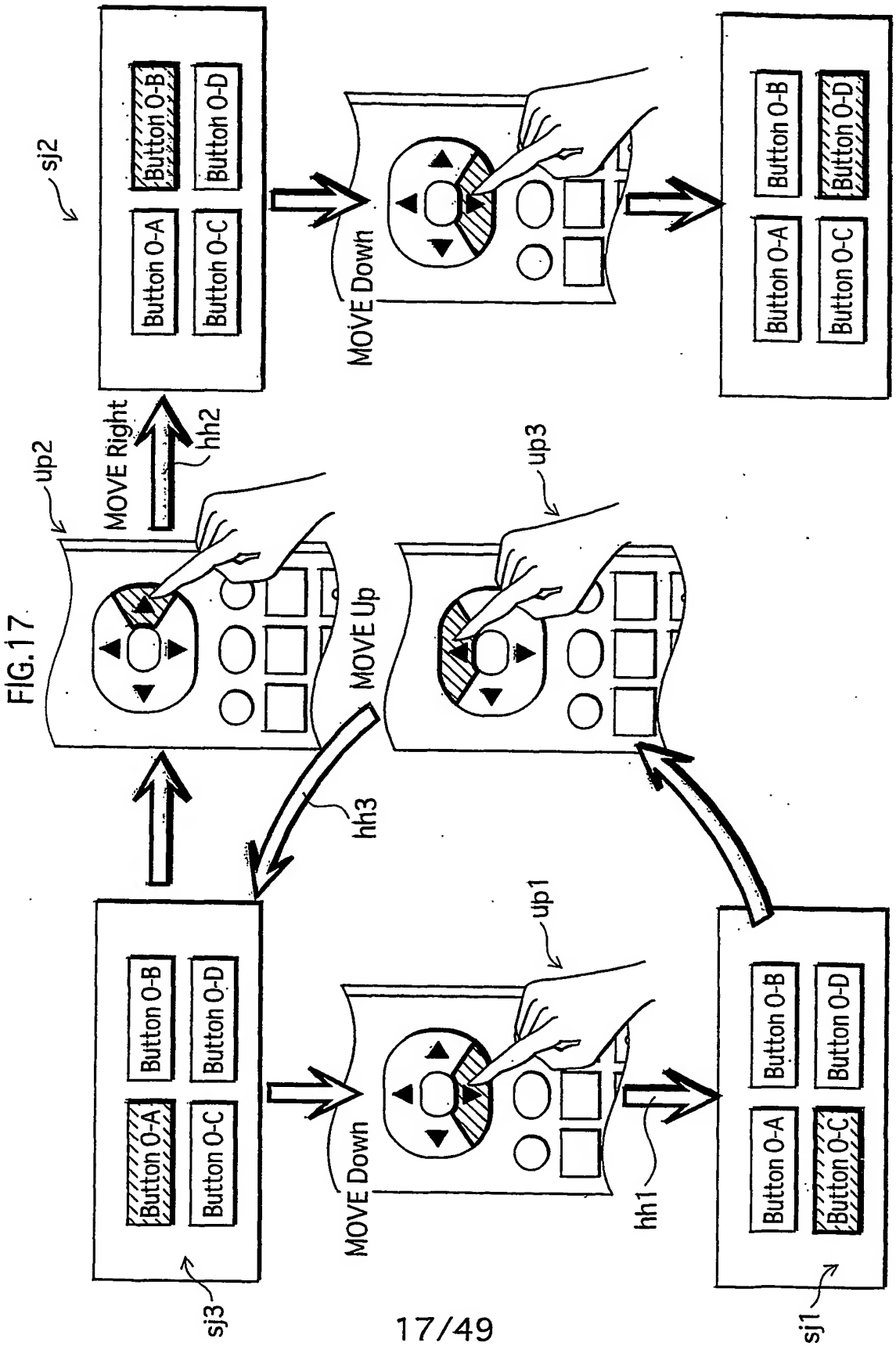

sj2
Button O-A
Button O-B
Button O-C
Button O-D
MOVE Down
MOVE Right
hh2
up2
up3
MOVE Up
hh3
up1
MOVE Down
hh1
sj3
sj1

FIG.18

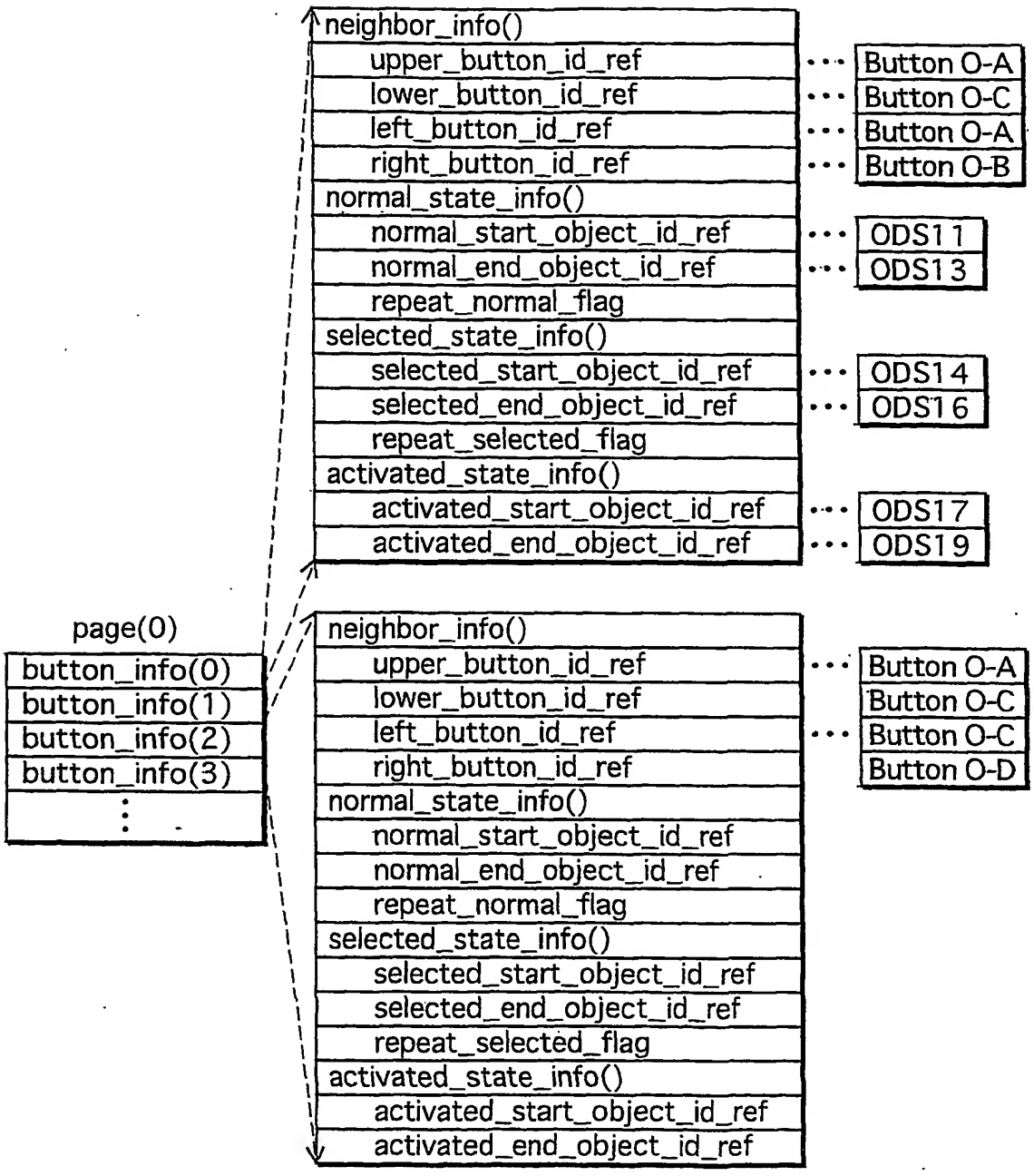

page(0)
button_info(0)
button_info(1)
button_info(2)
button_info(3)
neighbor_info()
upper_button_id_ref
lower_button_id_ref
left_button_id_ref
right_button_id_ref
normal_state_info()
normal_start_object_id_ref
normal_end_object_id_ref
repeat_normal_flag
selected_state_info()
selected_start_object_id_ref
selected_end_object_id_ref
repeat_selected_flag
activated_state_info()
activated_start_object_id_ref
activated_end_object_id_ref
Button O-A
Button O-C
Button O-A
Button O-B
ODS11
ODS13
ODS14
ODS16
ODS17
ODS19
neighbor_info()
upper_button_id_ref
lower_button_id_ref
left_button_id_ref
right_button_id_ref
normal_state_info()
normal_start_object_id_ref
normal_end_object_id_ref
repeat_normal_flag
selected_state_info()
selected_start_object_id_ref
selected_end_object_id_ref
repeat_selected_flag
activated_state_info()
activated_start_object_id_ref
activated_end_object_id_ref
Button O-A
Button O-C
Button O-C
Button O-D

FIG.19

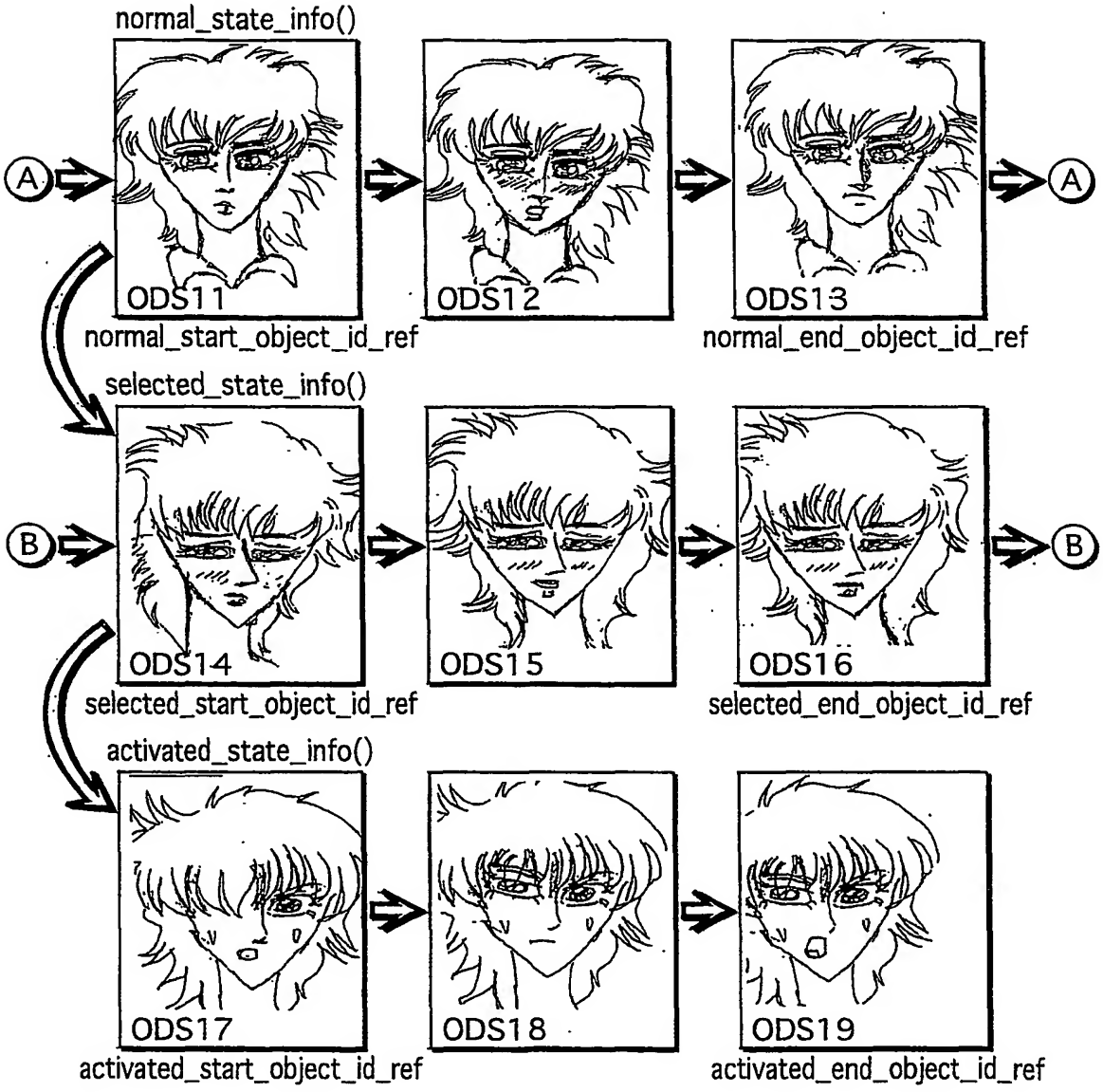

normal_state_info()
A
ODS11
ODS12
ODS13
A
normal_start_object_id_ref
normal_end_object_id_ref
selected_state_info()
B
ODS14
ODS15
ODS16
B
selected_start_object_id_ref
selected_end_object_id_ref
activated_state_info()
ODS17
ODS18
ODS19
activated_start_object_id_ref
activated_end_object_id_ref

FIG.20

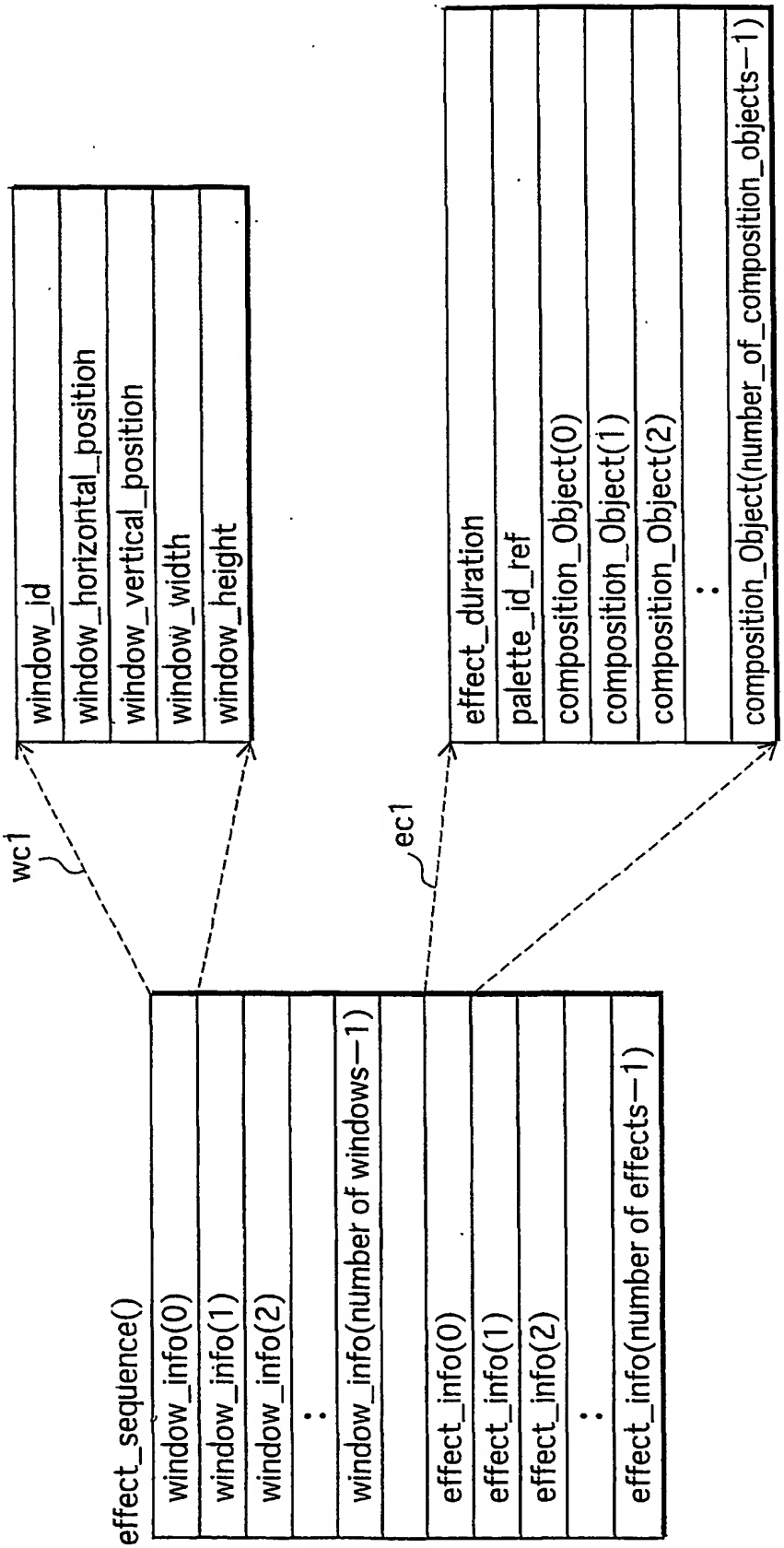

effect_sequence()
window_info(0)
window_info(1)
window_info(2)
window_info(number of windows−1)
effect_info(0)
effect_info(1)
effect_info(2)
effect_info(number of effects−1)
wc1
window_id
window_horizontal_position
window_vertical_position
window_width
window_height
ec1
effect_duration
palette_id_ref
composition_Object(0)
composition_Object(1)
composition_Object(2)
composition_Object(number_of_composition_objects−1)

FIG.21A

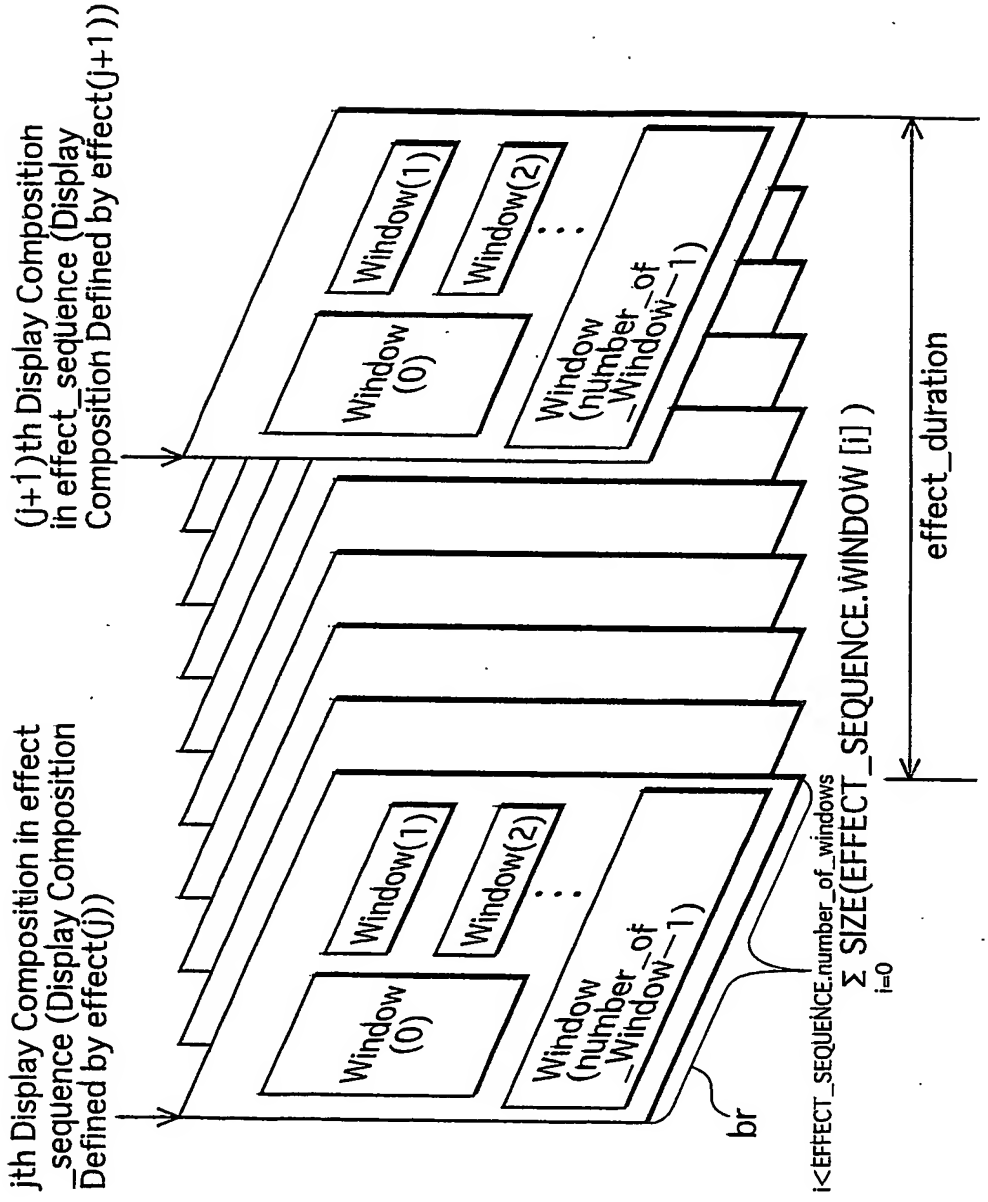


FIG.21B

$$effect_duration \geq ceil\left(\left(90000 * \sum_{i=0}^{i<EFFECT_SEQUENCE.number_of_windows} SIZE(EFFECT_SEQUENCE.WINDOW\ [i]\ )\right)/(128 * 10^6)\right)$$

FIG.22

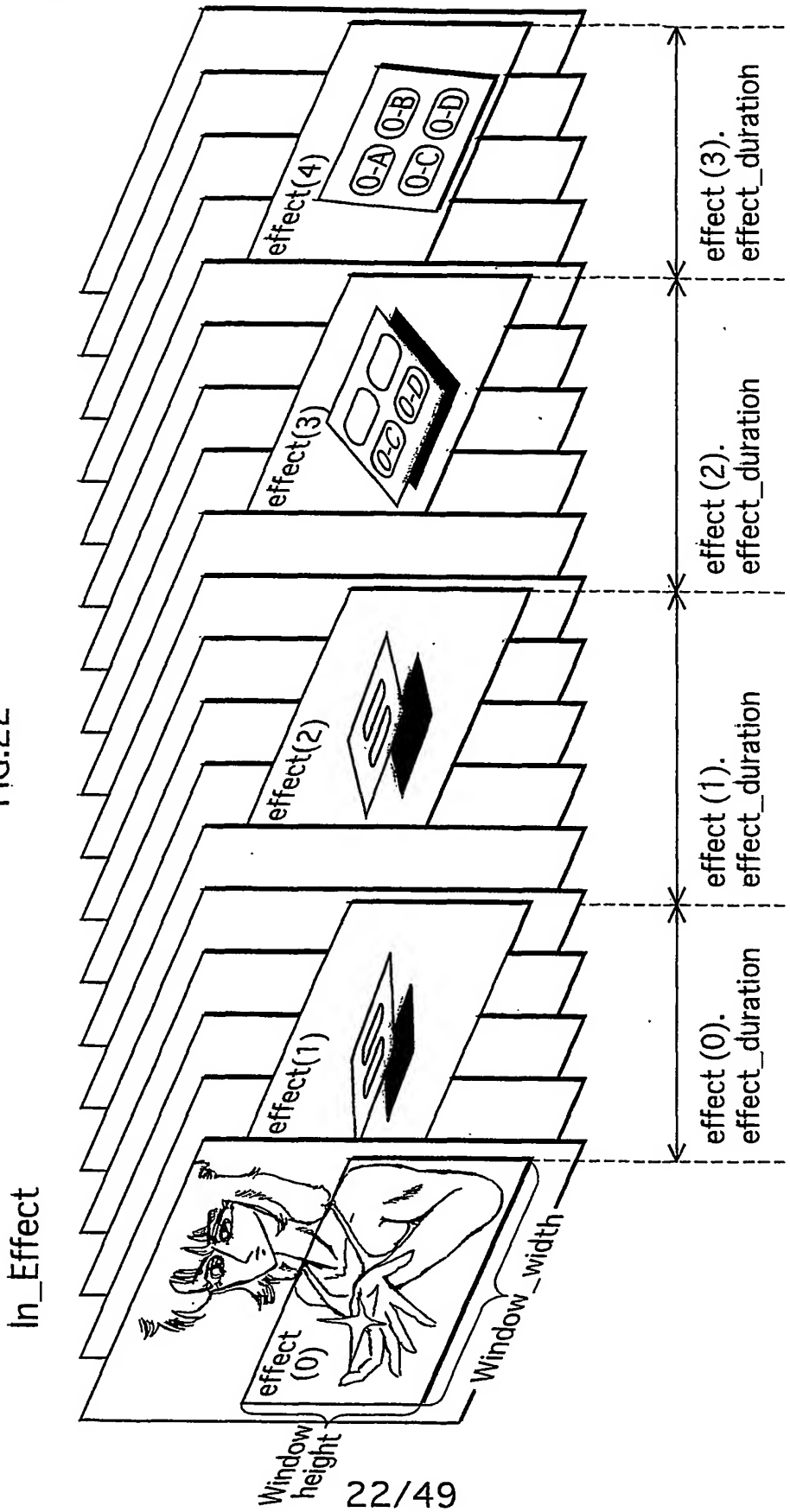

In_Effect
effect (0).
effect_duration
effect (1).
effect_duration
effect (2).
effect_duration
effect (3).
effect_duration
effect(1)
effect(2)
effect(3)
effect(4)
O-A
O-B
O-C
O-D
effect
(0)
Window_width
Window
height

FIG.23

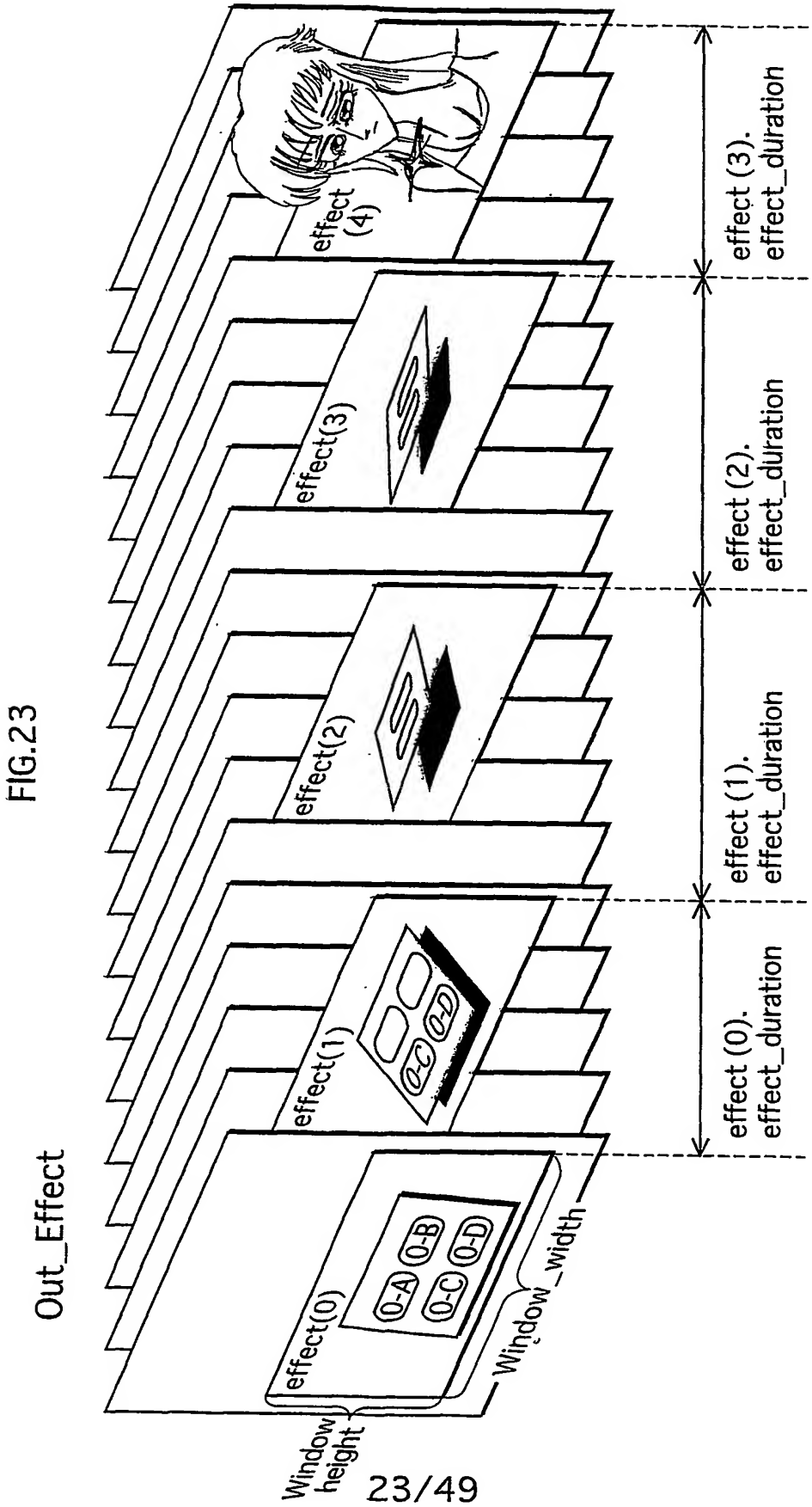

Out_Effect
effect(0)
O-A
O-B
O-C
O-D
Window_width
Window height
effect(1)
O-A
O-D
effect(2)
effect(3)
effect (4)
effect (0).
effect_duration
effect (1).
effect_duration
effect (2).
effect_duration
effect (3).
effect_duration

FIG.24

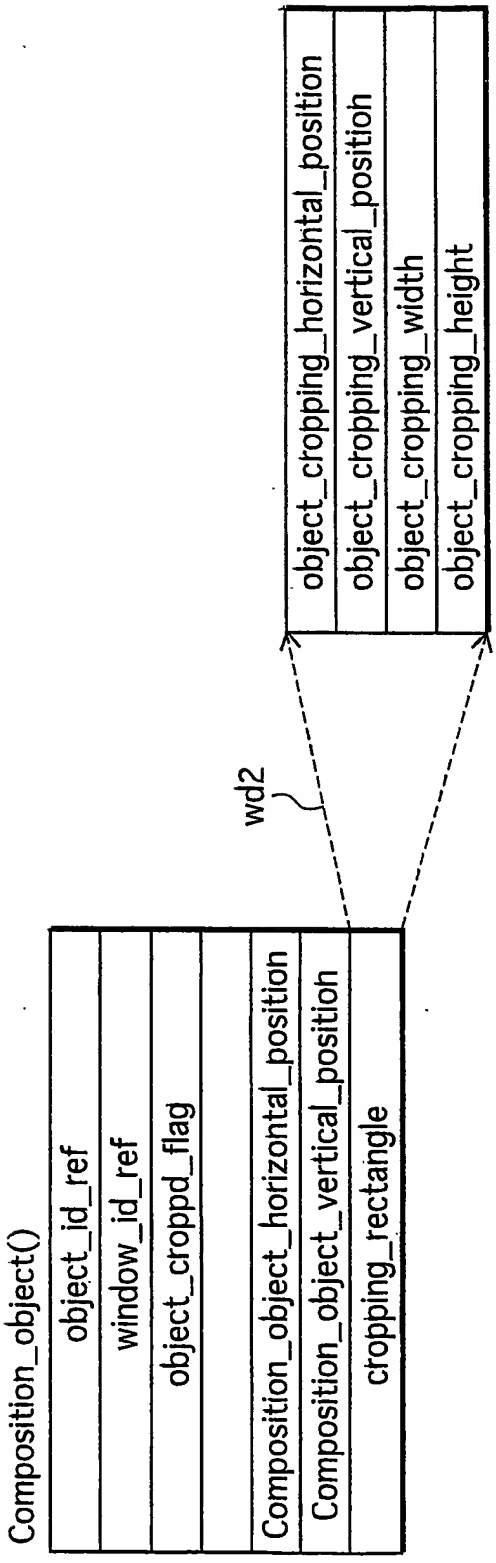

Composition_object()
object_id_ref
window_id_ref
object_croppd_flag
Composition_object_horizontal_position
Composition_object_vertical_position
cropping_rectangle
wd2
object_cropping_horizontal_position
object_cropping_vertical_position
object_cropping_width
object_cropping_height

FIG.25

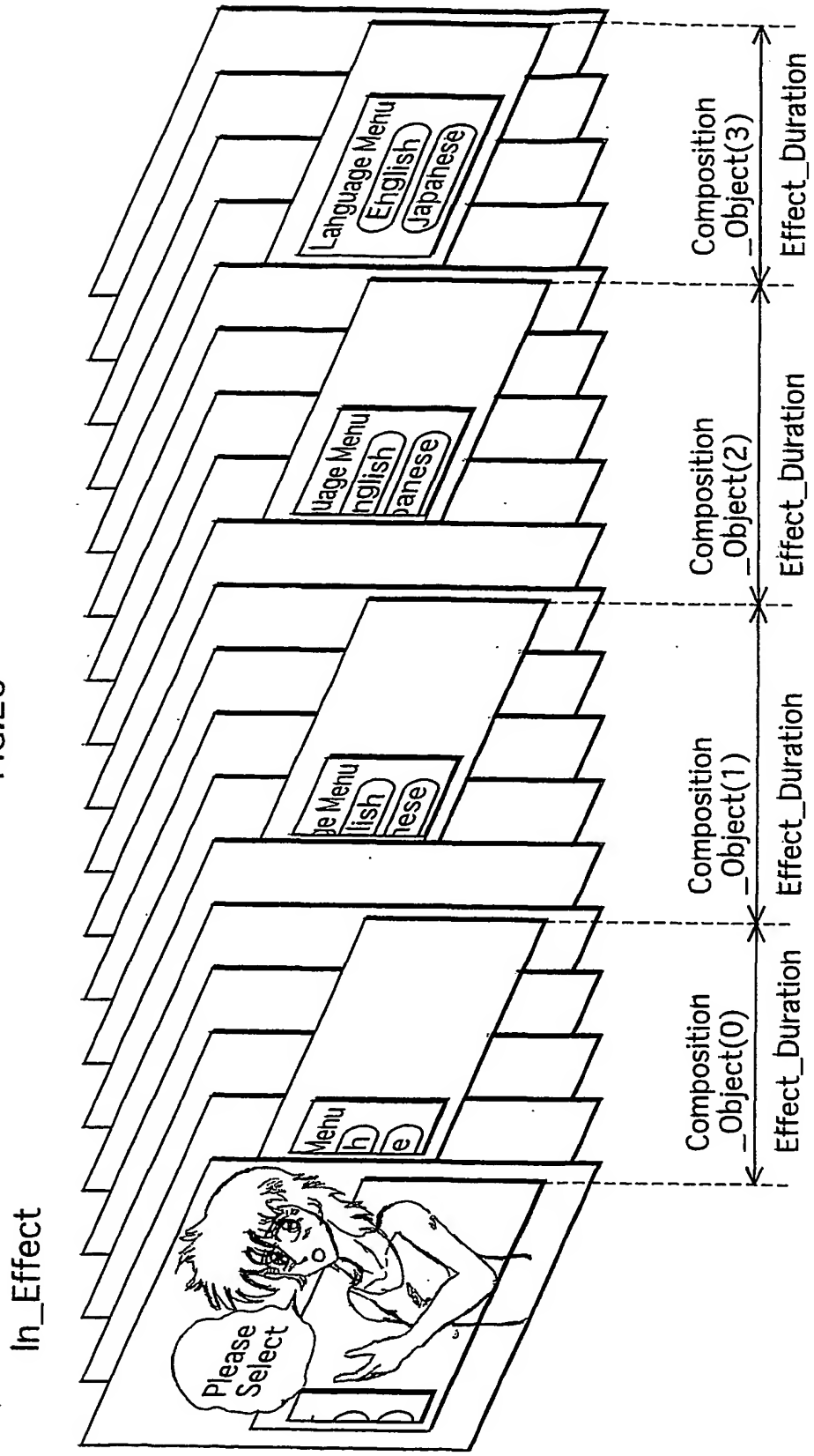

In_Effect
Please Select
Menu
Language Menu
English
Japanese
Composition _Object(0)
Composition _Object(1)
Composition _Object(2)
Composition _Object(3)
Effect_Duration
Effect_Duration
Effect_Duration
Effect_Duration

FIG.26

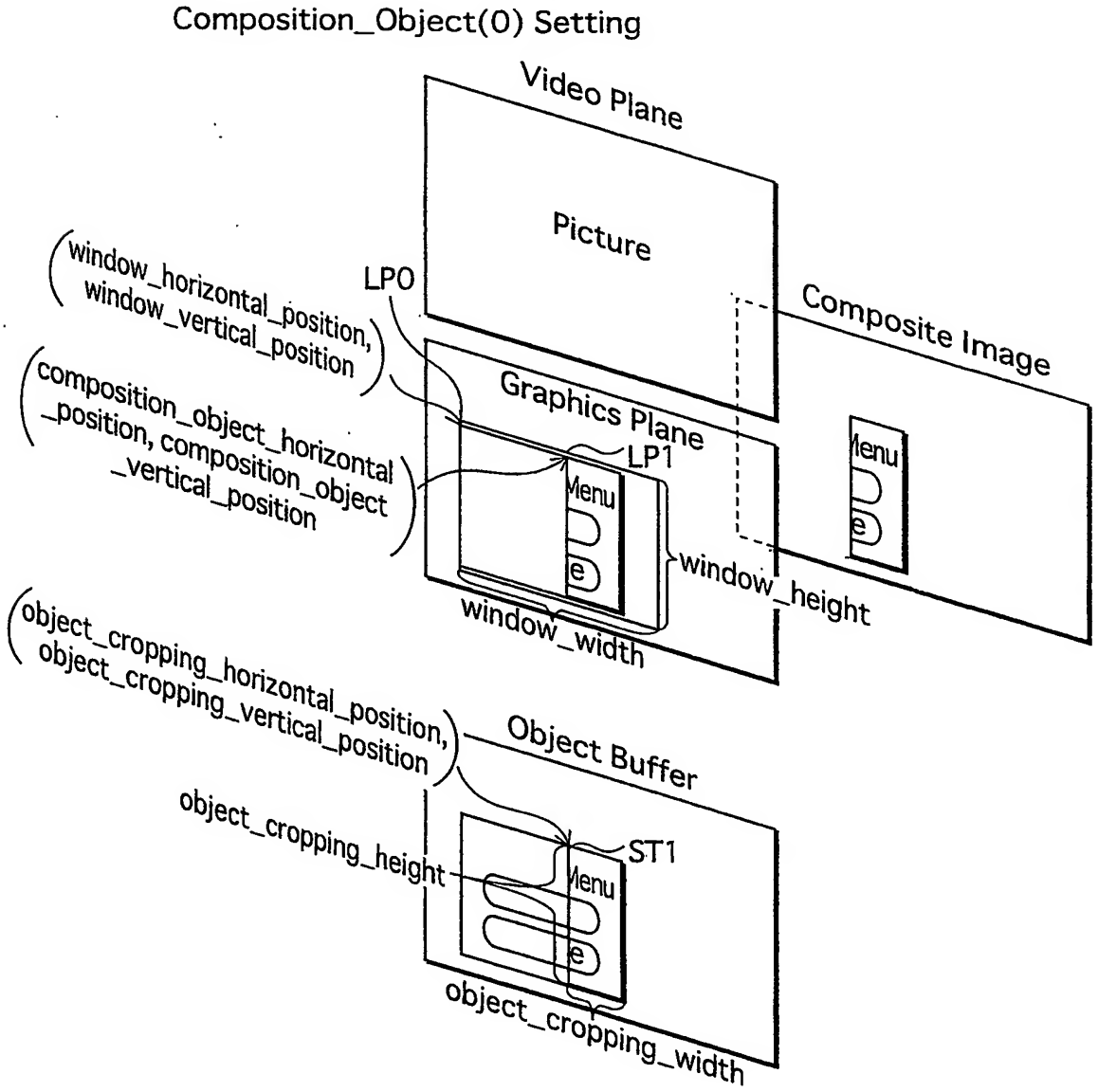

Composition_Object(0) Setting
Video Plane
Picture
Composite Image
LP0
window_horizontal_position,
window_vertical_position
composition_object_horizontal
_position, composition_object
_vertical_position
Graphics Plane
LP1
Menu
e
window_height
window_width
object_cropping_horizontal_position,
object_cropping_vertical_position
Object Buffer
ST1
object_cropping_height
object_cropping_width

FIG.27

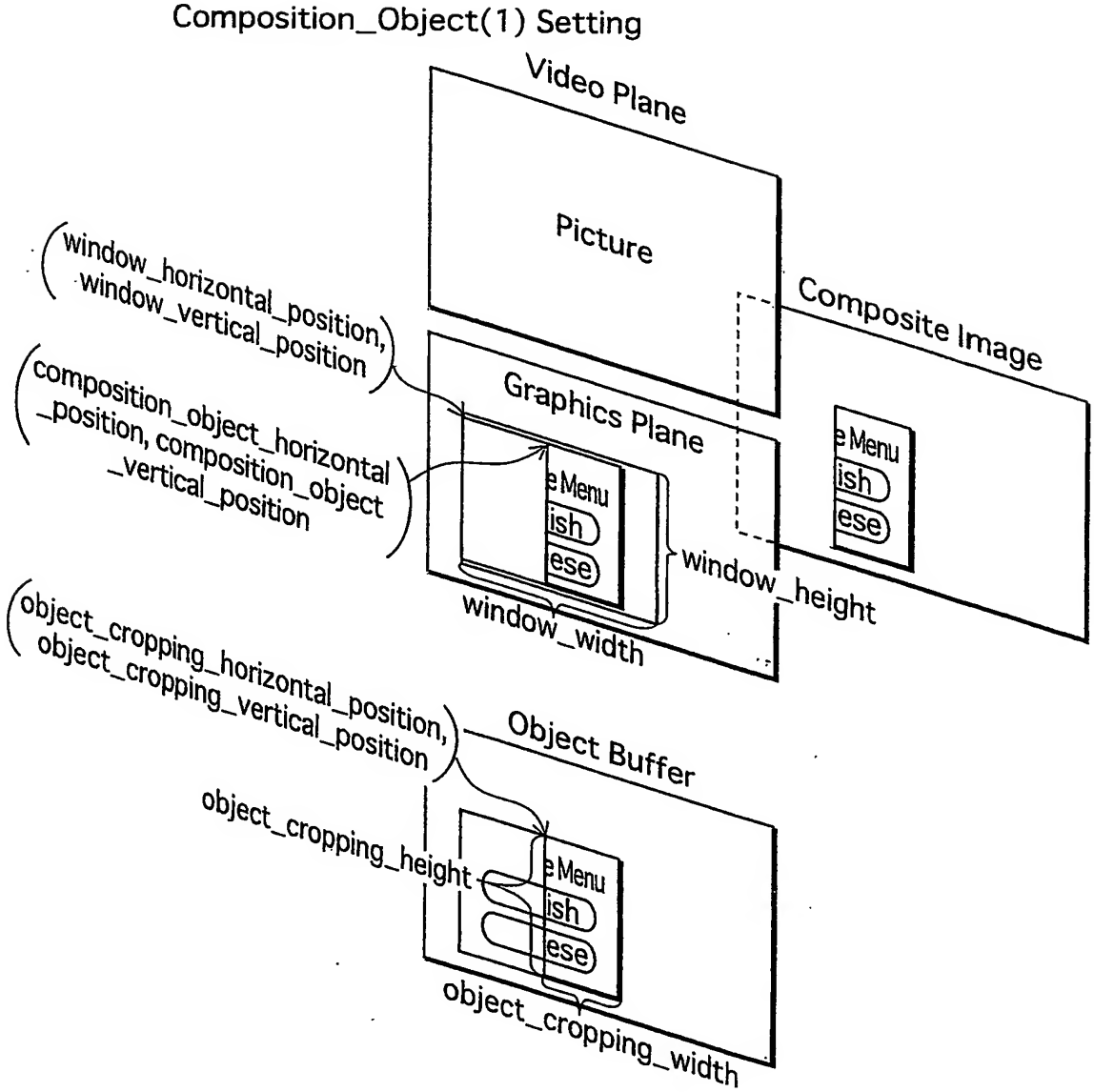

Composition_Object(1) Setting
Video Plane
Picture
Composite Image
window_horizontal_position,
window_vertical_position
composition_object_horizontal
_position, composition_object
_vertical_position
Graphics Plane
window_height
window_width
object_cropping_horizontal_position,
object_cropping_vertical_position
Object Buffer
object_cropping_height
object_cropping_width

FIG.28

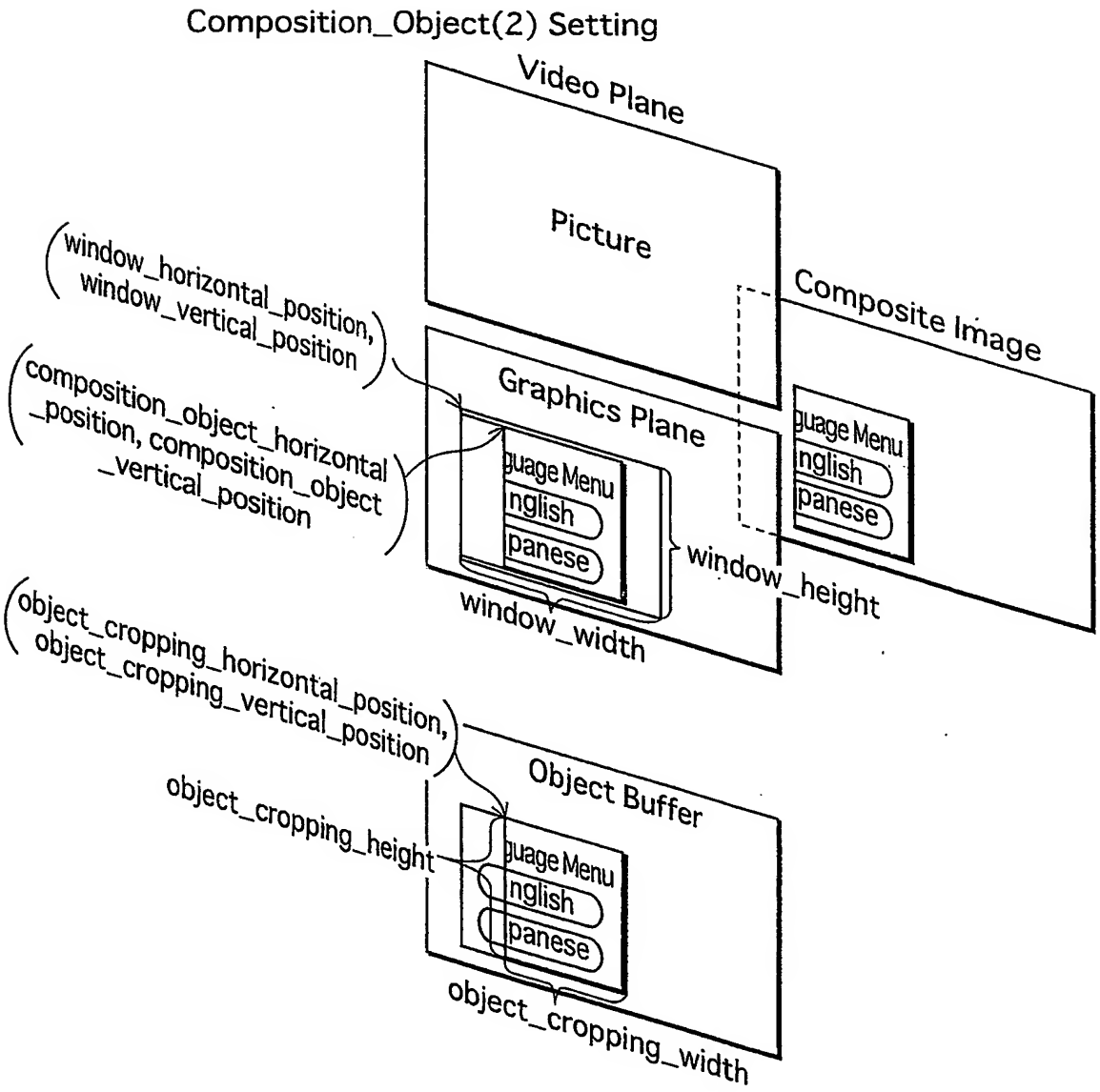

Composition_Object(2) Setting
Video Plane
Picture
Composite Image
window_horizontal_position,
window_vertical_position
composition_object_horizontal
_position, composition_object
_vertical_position
Graphics Plane
guage Menu
nglish
panese
window_height
window_width
object_cropping_horizontal_position,
object_cropping_vertical_position
object_cropping_height
Object Buffer
guage Menu
nglish
panese
object_cropping_width

FIG.29

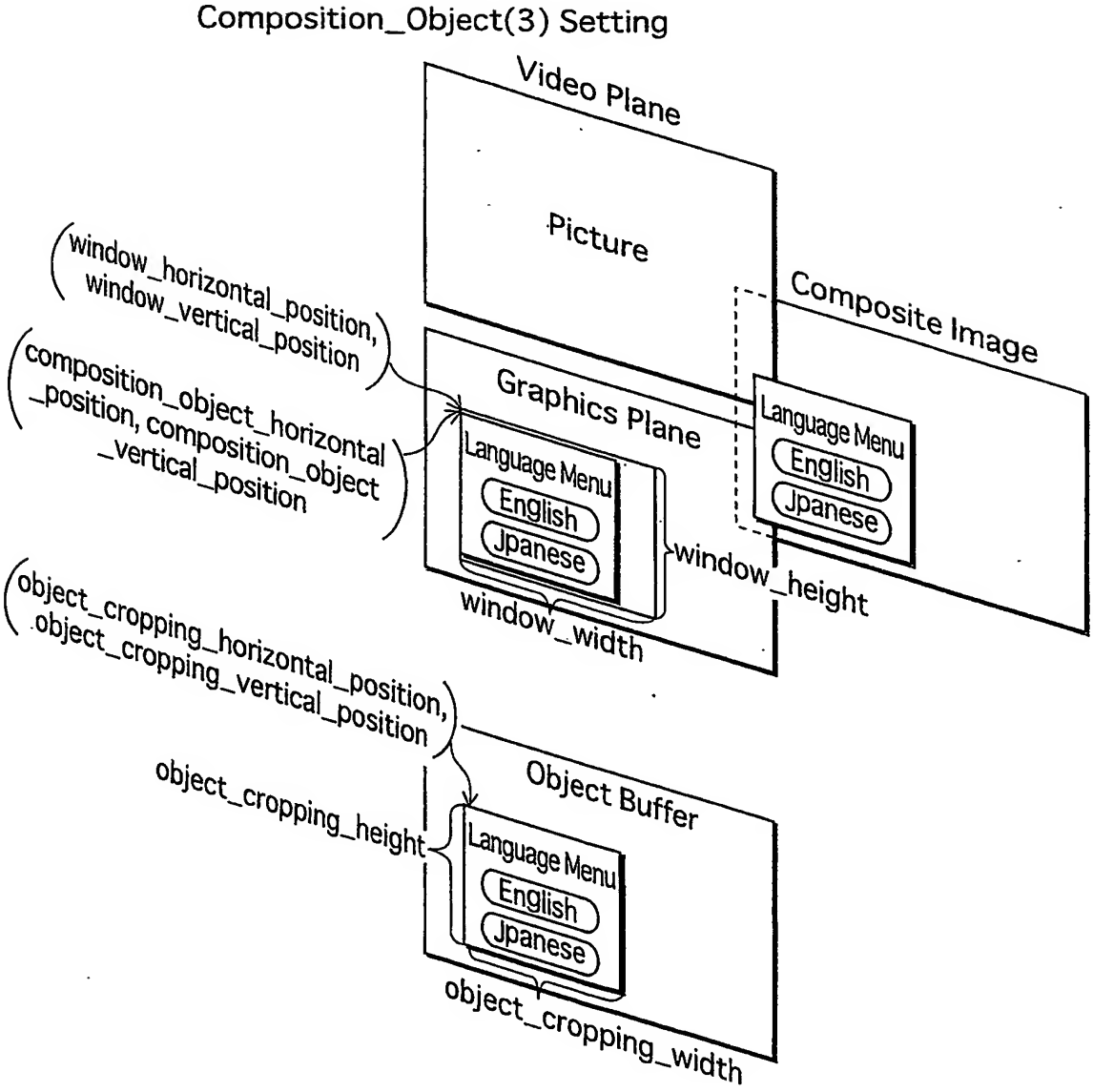

Composition_Object(3) Setting
Video Plane
Picture
Composite Image
window_horizontal_position,
window_vertical_position
composition_object_horizontal
_position, composition_object
_vertical_position
Graphics Plane
Language Menu
English
Jpanese
window_height
window_width
object_cropping_horizontal_position,
object_cropping_vertical_position
object_cropping_height
Object Buffer
Language Menu
English
Jpanese
object_cropping_width

FIG.30

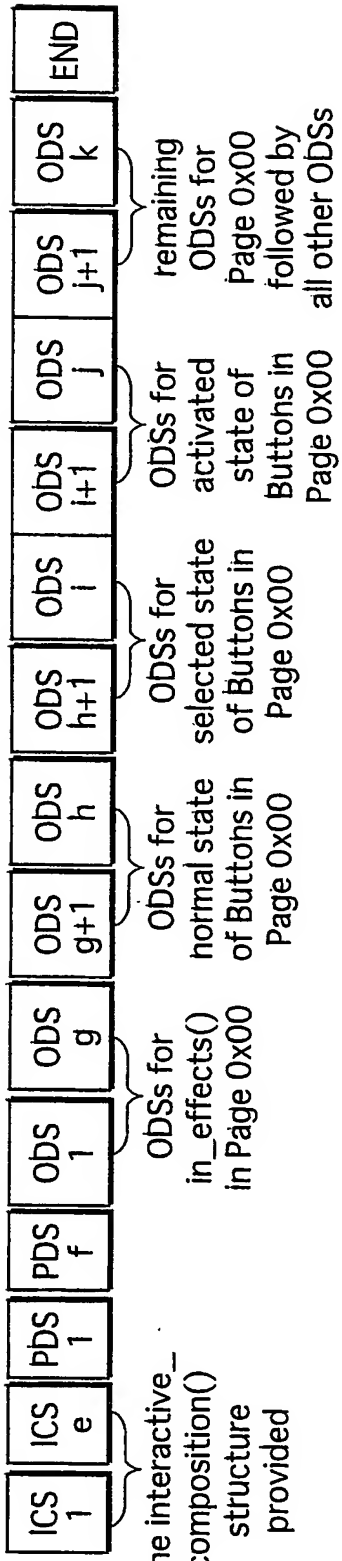

ICS 1
ICS e
PDS 1
PDS f
ODS 1
ODS g
ODS g+1
ODS h
ODS h+1
ODS i
ODS i+1
ODS j
ODS j+1
ODS k
END
one interactive_ composition() structure provided
ODSs for in_effects() in Page 0x00
ODSs for normal state of Buttons in Page 0x00
ODSs for selected state of Buttons in Page 0x00
ODSs for activated state of Buttons in Page 0x00
remaining ODSs for Page 0x00 followed by all other ODSs

FIG.31

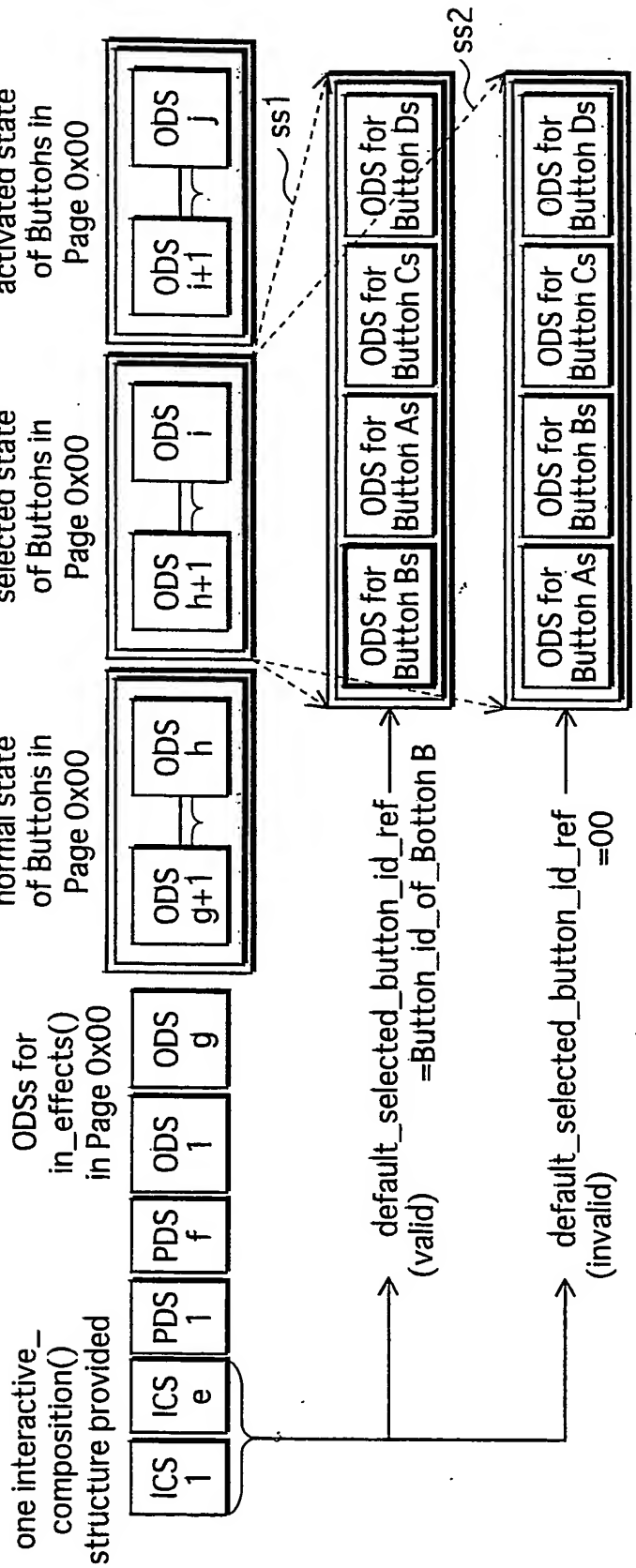

one interactive_ composition() structure provided
ICS 1
ICS e
PDS 1
PDS f
ODS 1
ODS g
ODSs for in_effects() in Page 0x00
ODS g+1
ODS h
ODSs for normal state of Buttons in Page 0x00
ODS h+1
ODS i
ODSs for selected state of Buttons in Page 0x00
ODS i+1
ODS j
ODSs for activated state of Buttons in Page 0x00
ss1
ss2
ODS for Button Bs
ODS for Button As
ODS for Button Cs
ODS for Button Ds
default_selected_button_id_ref =Button_id_of_Botton B (valid)
default_selected_button_id_ref =00 (invalid)

FIG.32A

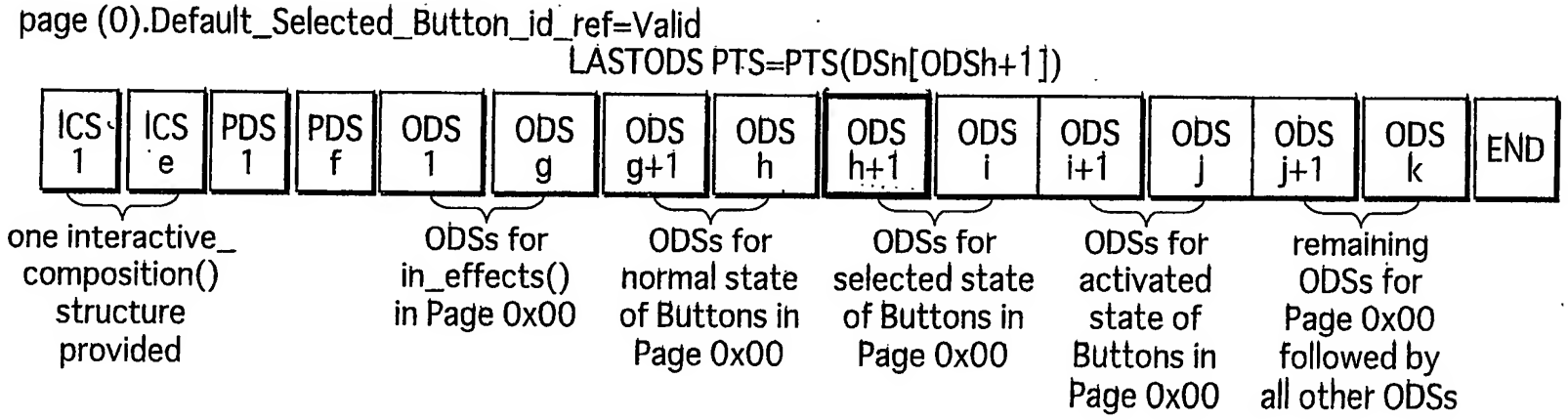


FIG.32B

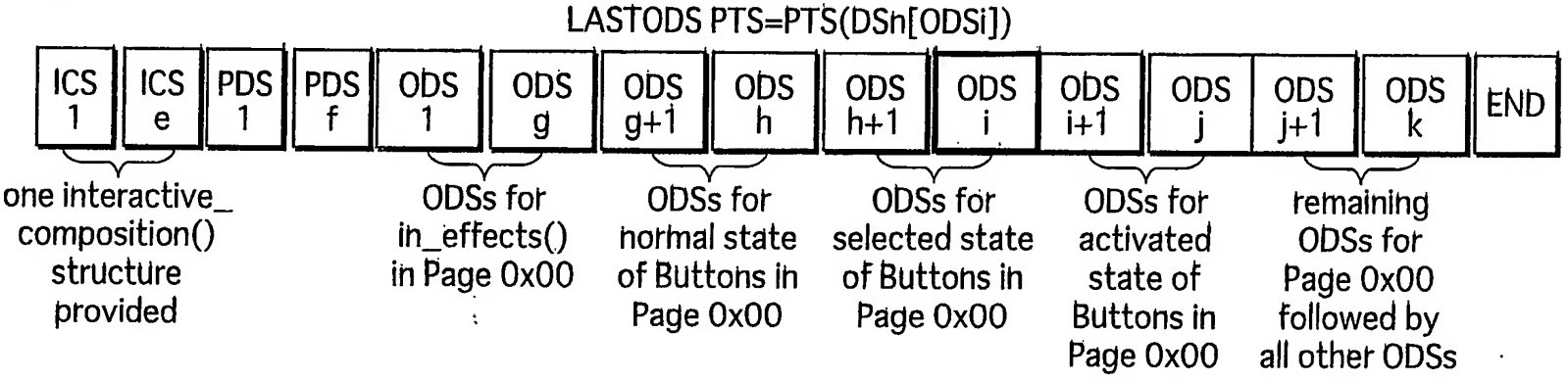


FIG.33A No ODSs for Selected State within DSn

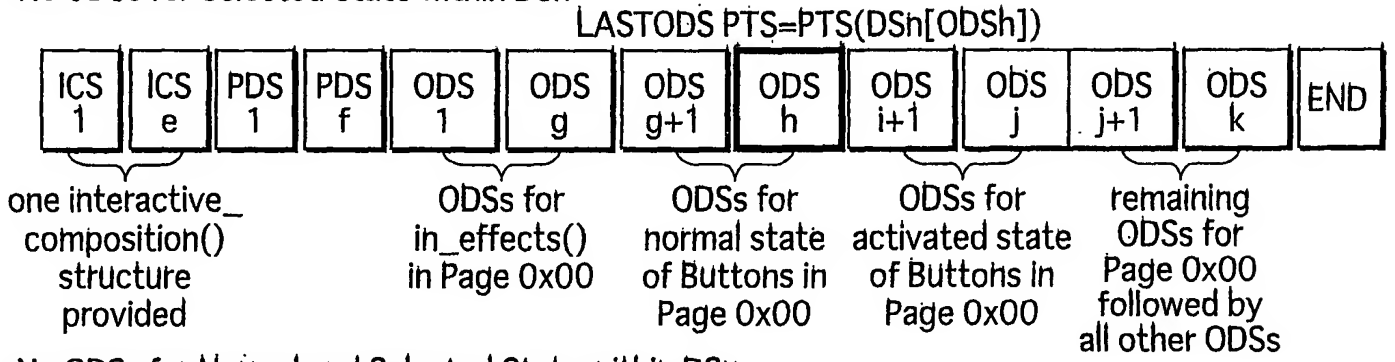


FIG.33B No ODSs for Normal and Selected State within DSn

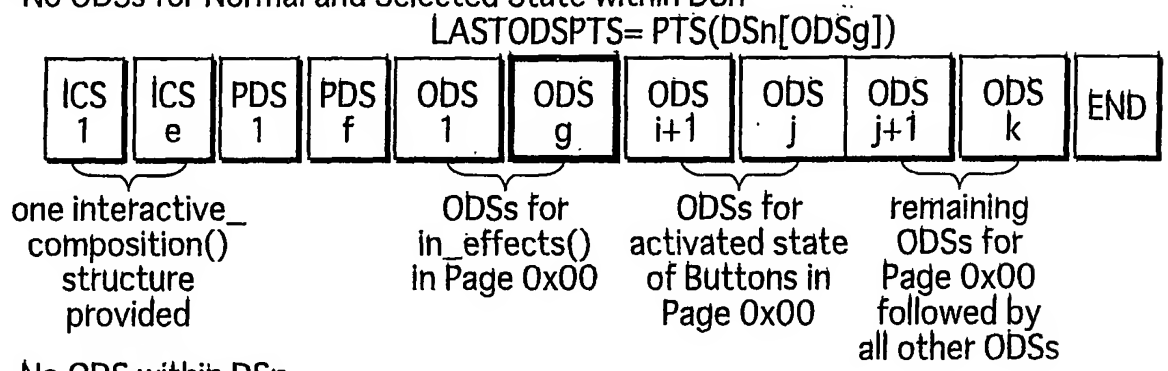


FIG.33C No ODS within DSn

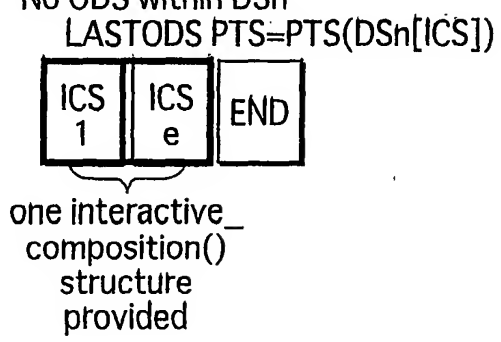


FIG.34A $PTS(DS_n[ICS]) \geqq DTS(DS_n[ICS]) + DECODEDURATION(DS_n) + TRANSFERDURATION(DS_n)$

Where :

- DECODEDURATION (DS_n) is calculated as follows :

```
if( DSn [ICS]. composition_state == EPOCH_START )
  return(max (LASTODSPTS(DSn)−DTS(DSn [ICS]), PLANECLEARTIME(DSn))
else
  return(LASTODSPTS(DSn)−DTS(DSn [ICS])
```

FIG.34B

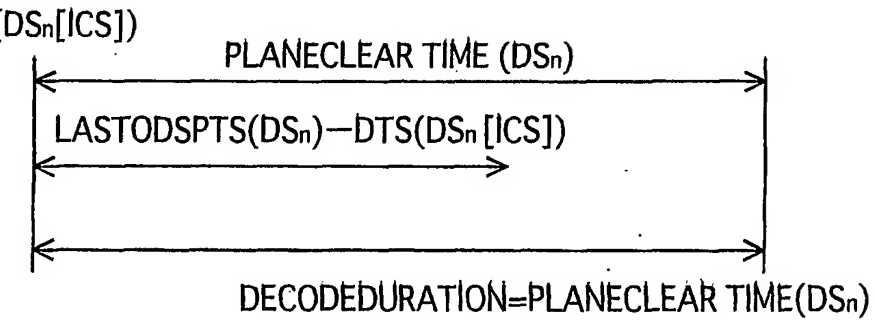


FIG.34C

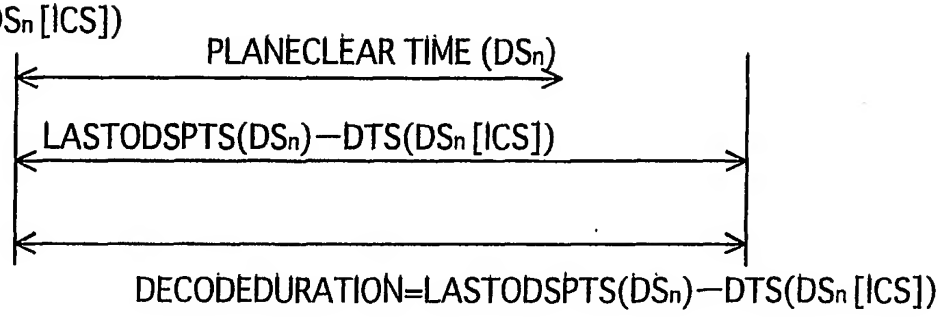


FIG.35A

Where :

$$EFFECTTD(DS_n)=ceil\left(\left(\left(90000*\sum_{i=0}^{i<ICS.PAGE[0].IN_EFFECTS.number_of_windows} SIZE(DS_n[ICS].PAGE[0].IN_EFFECTS.WINDOW[i])\right)/(128*10^6)\right)\right)$$

FIG.35B

$$PAGEDEFAULTTD(DS_n)=ceil\left(\left(\left(90000*\left(\begin{array}{l}\sum_{i=0}^{i<ICS.PAGE[0].number_of_button} NBSIZE(DS_n, DS_n[ICS].PAGE[0].button)\\ -NBSIZE(DS_n, DS_n[ICS].PAGE[0].default_selected_button_id_ref)\\ +SBSIZE(DS_n, DS_n[ICS].PAGE[0].default_selected_button_id_ref)\end{array}\right)\right)/(128*10^6)\right)\right)$$

FIG.35C

$$PAGENODEFAULTTD(DS_n)=ceil\left(\left(90000*\left(\begin{array}{l}\sum_{i=0}^{i<ICS.PAGE[0].number_of_button} NBSIZE(DS_n, DS_n[ICS].PAGE[0].button)\\ +BSIZE(DS_n, LRG\{button : button\in DS_n[ICS].PAGE[0].button\})\\ -NBSIZE(DS_n, LRG\{button : button\in DS_n[ICS].PAGE[0].button\})\end{array}\right)/(128*10^6)\right)\right)$$

FIG.36

$PTS(DS_n[ICS]) \geqq DTS(DS_n[ICS]) + DECODEDURATION(DS_n) + TRANSFERDURATION(DS_n)$

Where :

- TRANSFERDURATION (DS_n) is calculated as follows :

```
if ( DSn[ICS]. PAGE[0]. IN_EFFECTS. number_of_effects ! =0 )
  return EFFECTTD(DSn)
else if(DSn[ICS]. PAGE[0]. default_selected_button_id_ref == 0xFFFF )
  return PAGENODEFAULTTD(DSn)
else
  return PAGEDEFAULTTD(DSn)
```

FIG.37

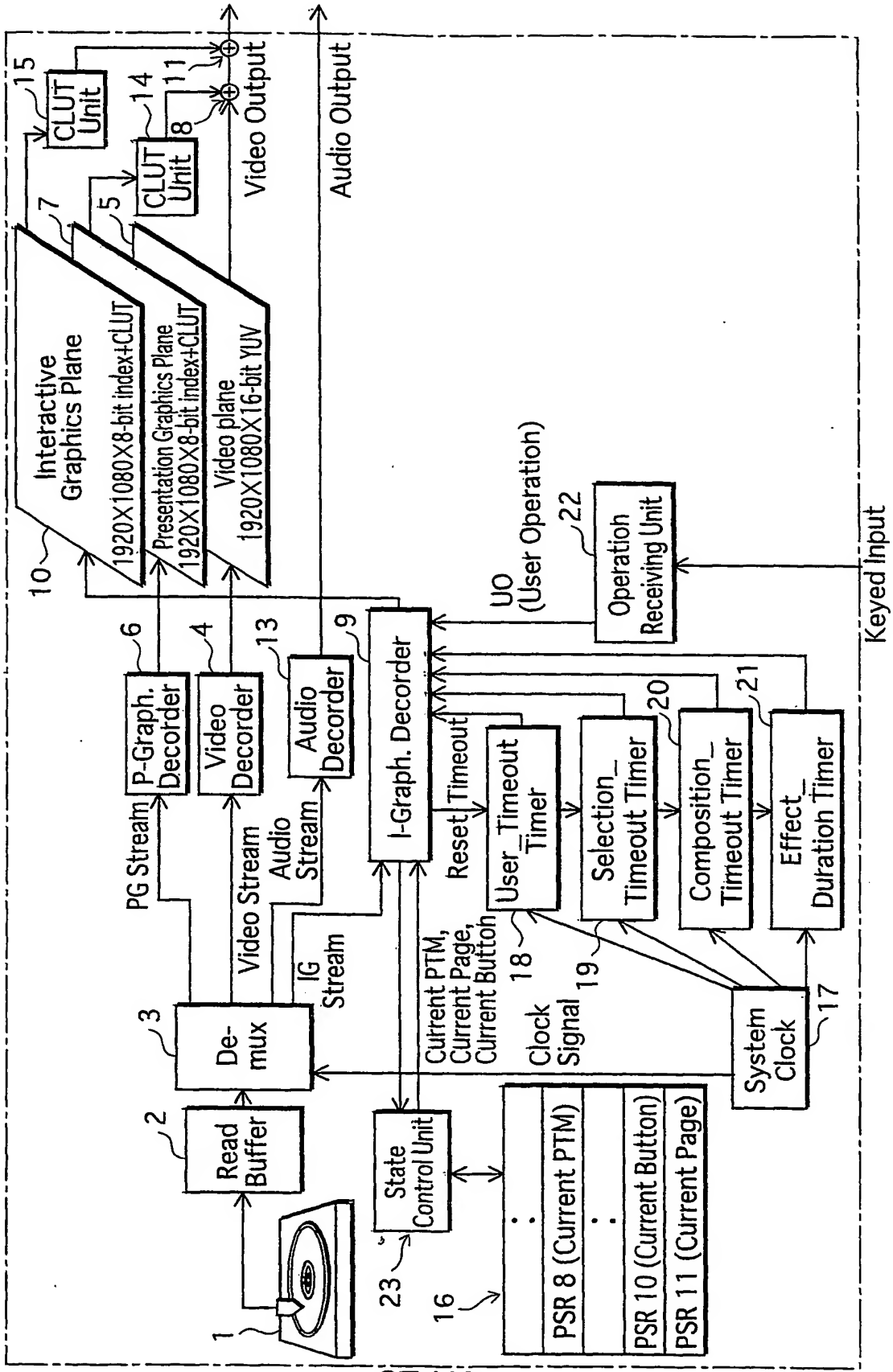

Interactive Graphics Plane
1920X1080X8-bit index+CLUT
Presentation Graphics Plane
1920X1080X8-bit index+CLUT
Video plane
1920X1080X16-bit YUV
CLUT Unit
CLUT Unit
Video Output
Audio Output
Keyed Input
UO (User Operation)
Operation Receiving Unit
P-Graph. Decorder
Video Decorder
Audio Decorder
I-Graph. Decorder
PG Stream
Video Stream
Audio Stream
IG Stream
Reset
Timeout
User_Timeout Timer
Selection_ Timeout Timer
Composition_ Timeout Timer
Effect_ Duration Timer
De-mux
Read Buffer
State Control Unit
Current PTM, Current Page, Current Button
Clock Signal
System Clock
PSR 8 (Current PTM)
PSR 10 (Current Button)
PSR 11 (Current Page)

FIG.38A

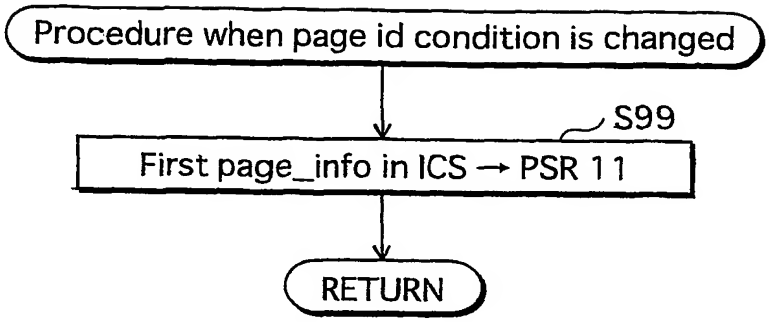


FIG.38B

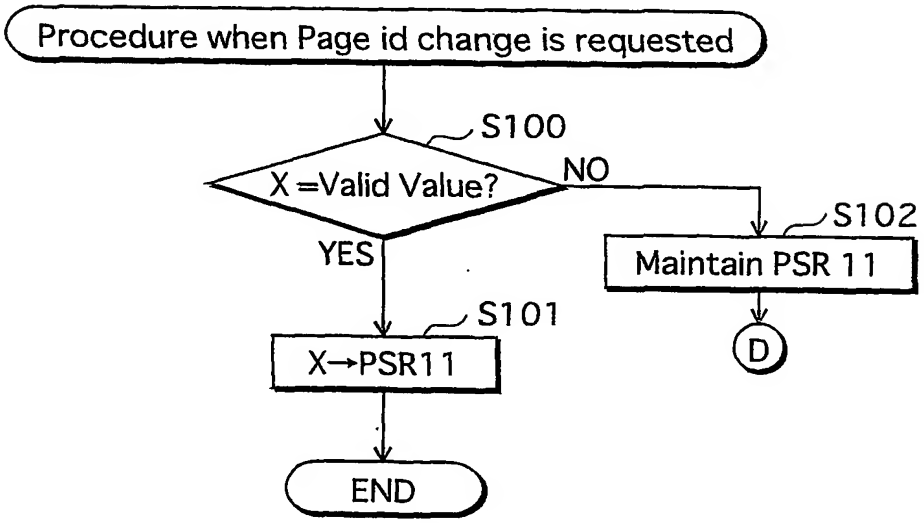


FIG.39A

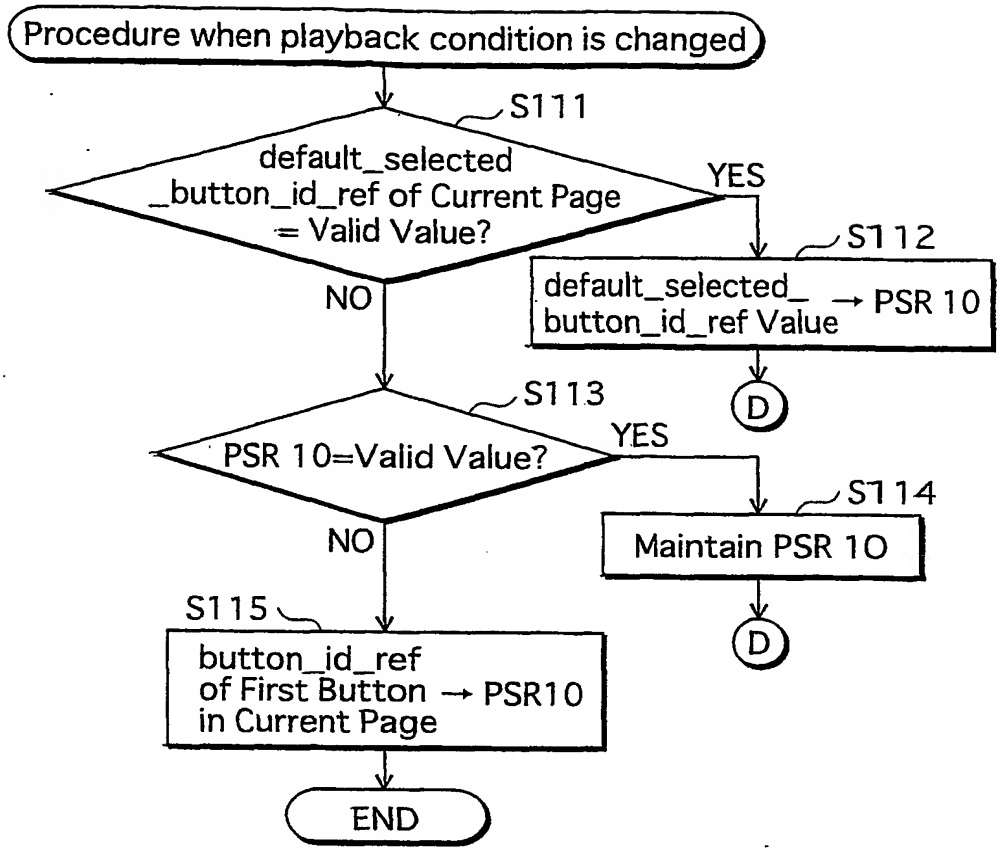
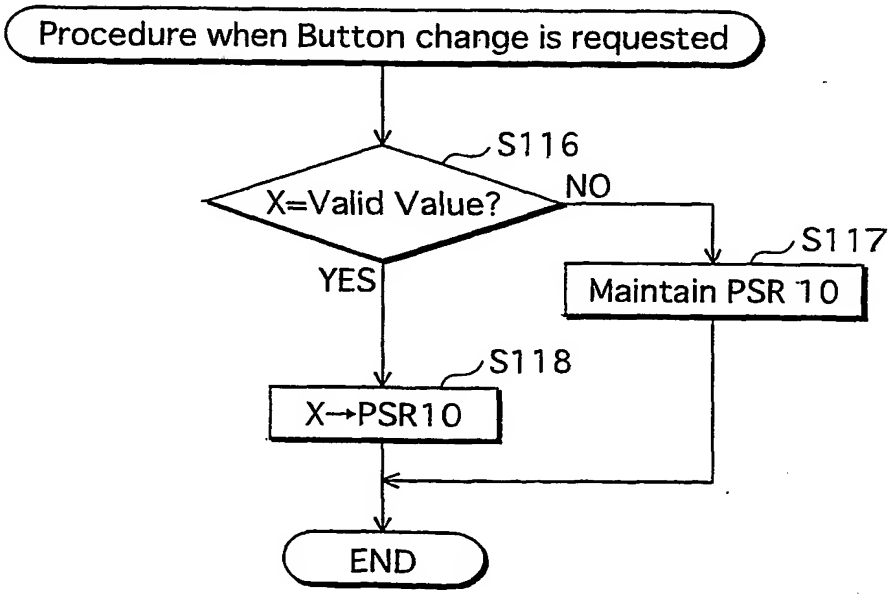


FIG.39B



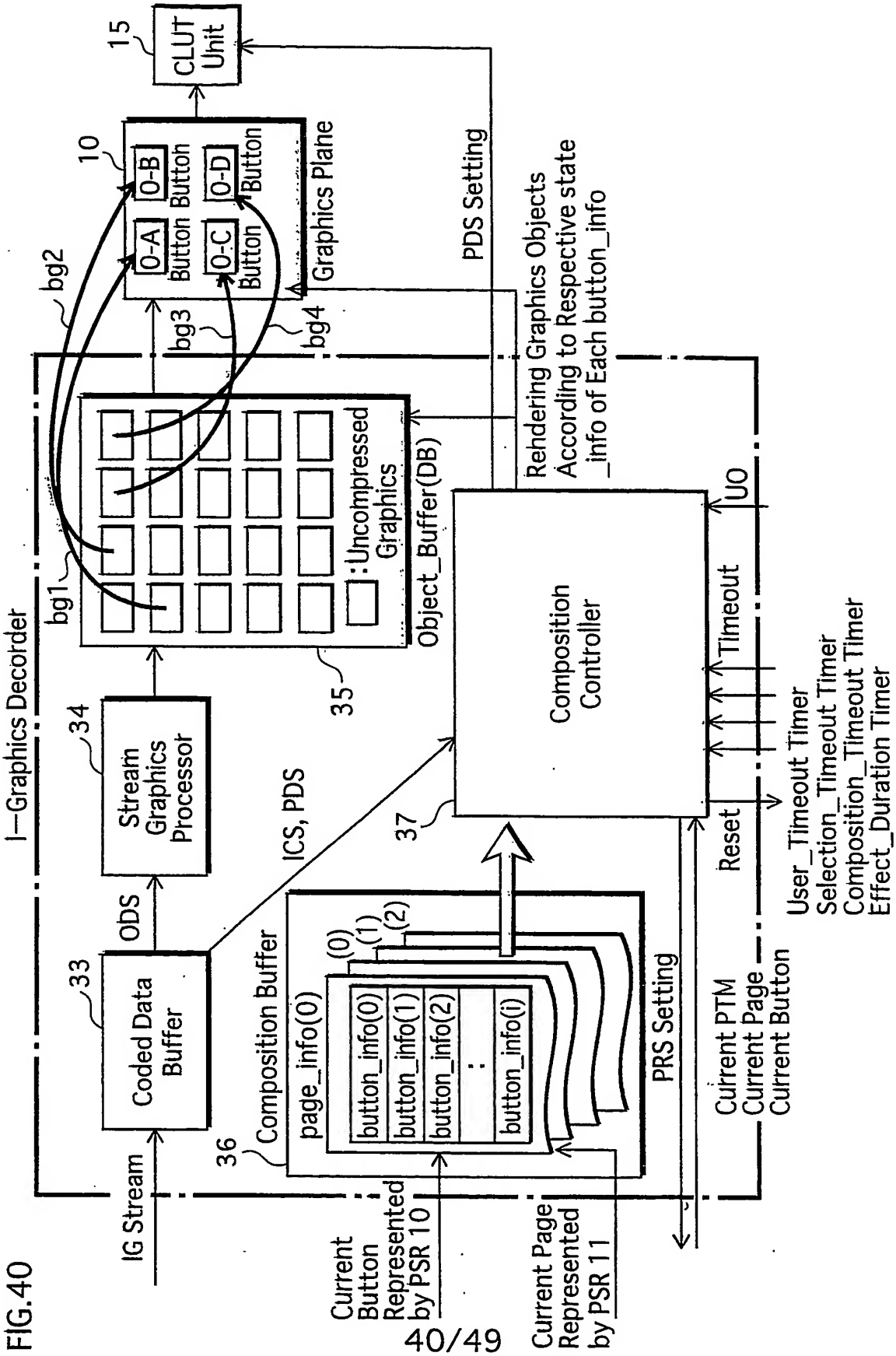

15
CLUT Unit
10
O-A Button
O-B Button
O-C Button
O-D Button
Graphics Plane
bg1
bg2
bg3
bg4
:Uncompressed Graphics
Object_Buffer(DB)
35
PDS Setting
Rendering Graphics Objects According to Respective state _info of Each button_info
I—Graphics Decorder
34
Stream Graphics Processor
ODS
33
Coded Data Buffer
ICS, PDS
37
Composition Controller
UO
Timeout
Reset
User_Timeout Timer
Selection_Timeout Timer
Composition_Timeout Timer
Effect_Duration Timer
36
Composition Buffer
page_info(0)
(0)
(1)
(2)
button_info(0)
button_info(1)
button_info(2)
button_info(i)
PRS Setting
Current PTM
Current Page
Current Button
IG Stream
Current Button Represented by PSR 10
Current Page Represented by PSR 11

FIG.40

FIG.41

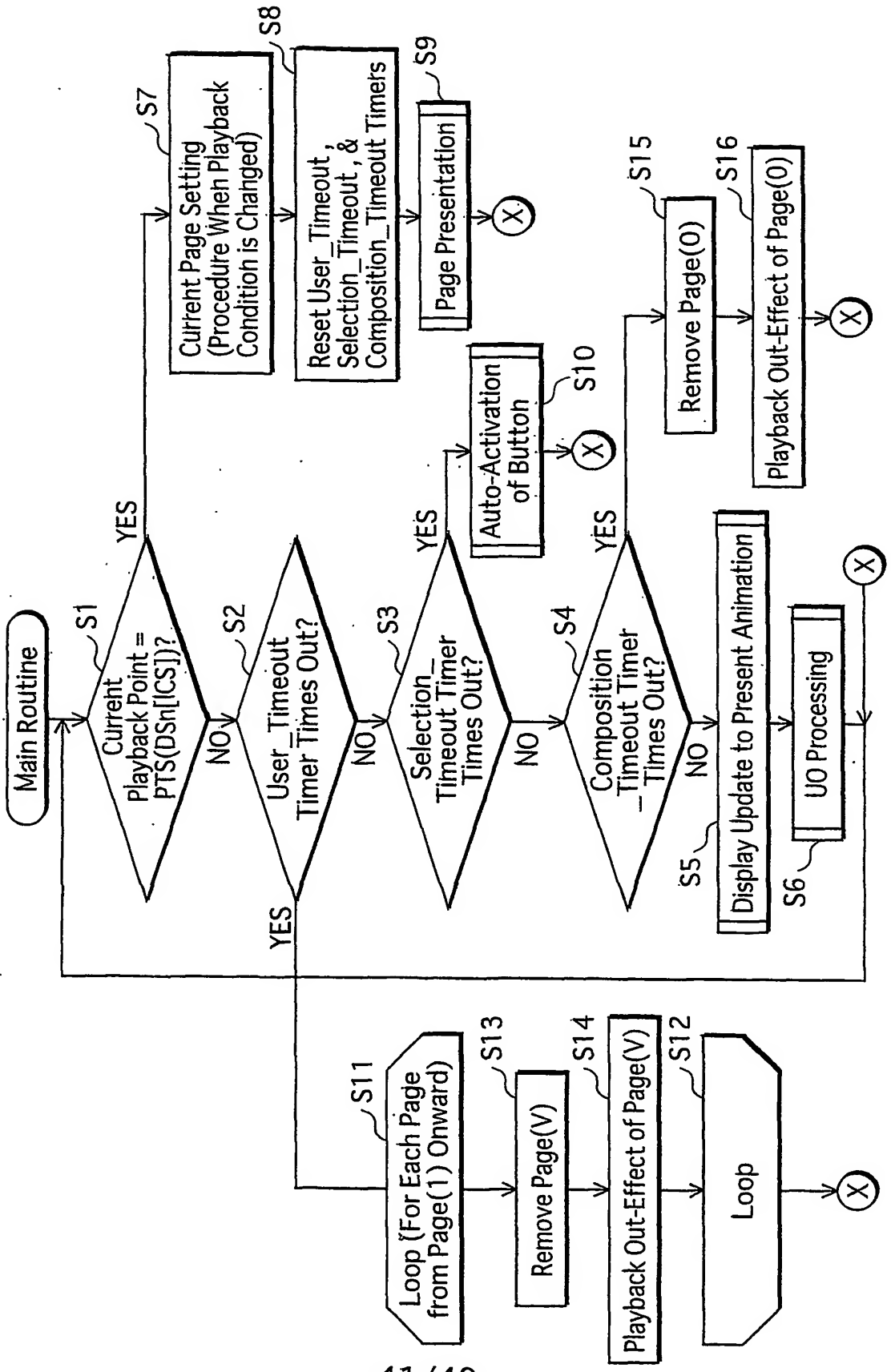

Main Routine
S1
Current Playback Point = PTS(DSn[ICS])?
YES
NO
S2
User_Timeout Timer Times Out?
YES
NO
S3
Selection_ Timeout Timer Times Out?
YES
NO
S4
Composition _Timeout Timer Times Out?
YES
NO
S5
Display Update to Present Animation
S6
UO Processing
S7
Current Page Setting (Procedure When Playback Condition is Changed)
S8
Reset User_Timeout , Selection_Timeout , & Composition_Timeout Timers
S9
Page Presentation
S10
Auto-Activation of Button
S11
Loop (For Each Page from Page(1) Onward)
S12
Loop
S13
Remove Page(V)
S14
Playback Out-Effect of Page(V)
S15
Remove Page(0)
S16
Playback Out-Effect of Page(0)

FIG.42

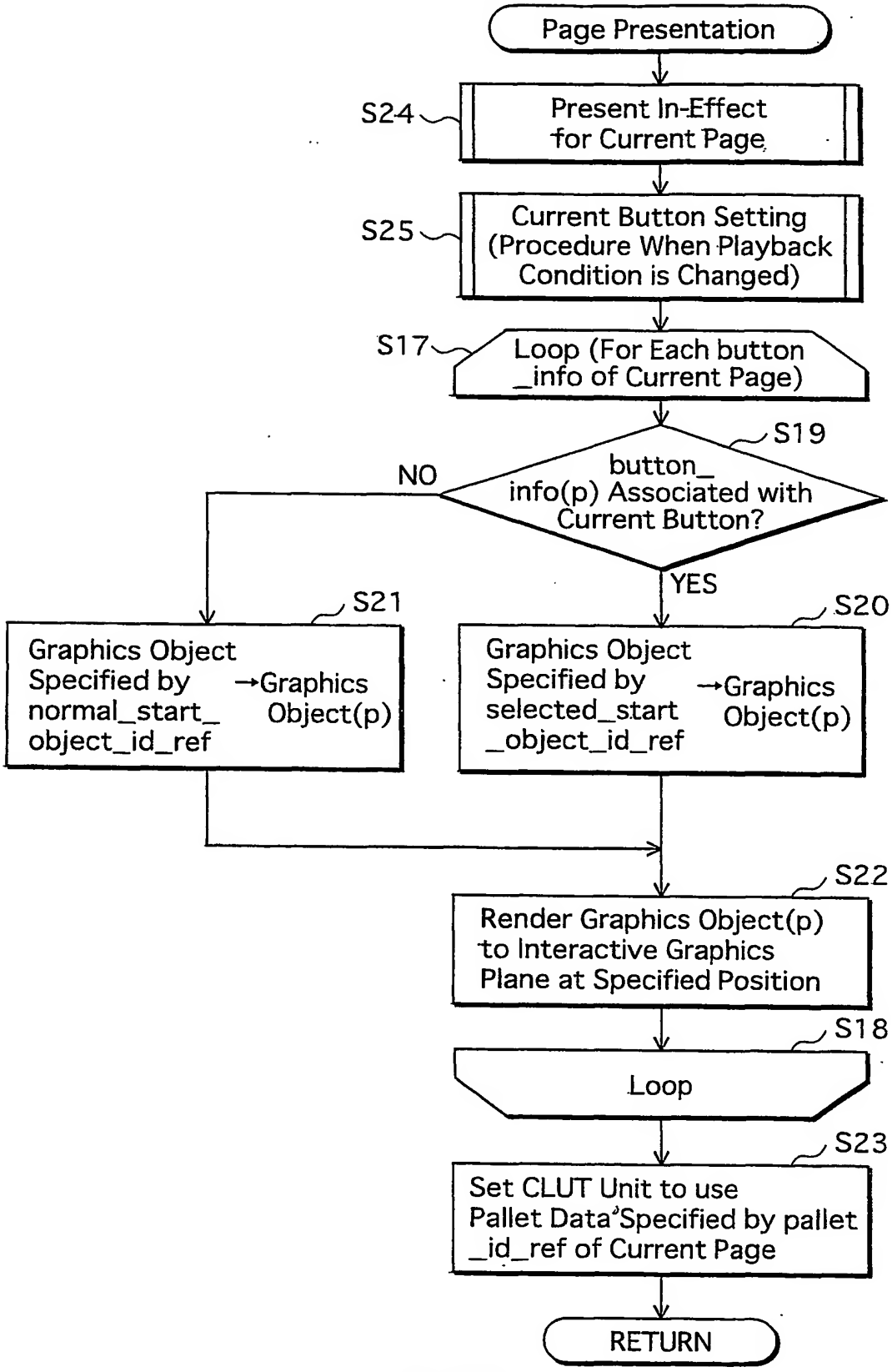

Page Presentation
S24
Present In-Effect for Current Page
S25
Current Button Setting (Procedure When Playback Condition is Changed)
S17
Loop (For Each button _info of Current Page)
S19
button_info(p) Associated with Current Button?
NO
YES
S21
Graphics Object Specified by normal_start_object_id_ref →Graphics Object(p)
S20
Graphics Object Specified by selected_start_object_id_ref →Graphics Object(p)
S22
Render Graphics Object(p) to Interactive Graphics Plane at Specified Position
S18
Loop
S23
Set CLUT Unit to use Pallet Data Specified by pallet _id_ref of Current Page
RETURN

FIG.43

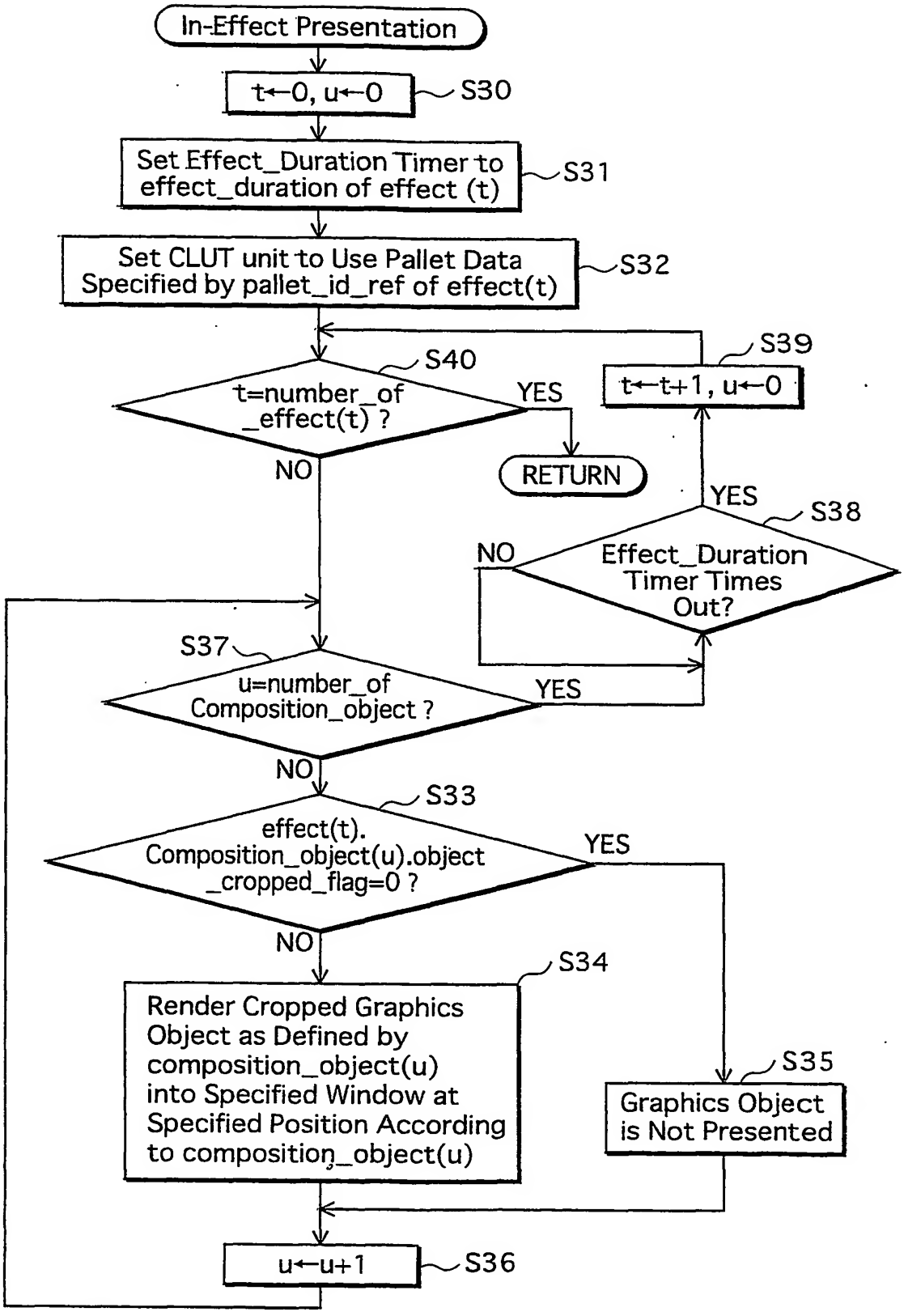

In-Effect Presentation
t←0, u←0
S30
Set Effect_Duration Timer to effect_duration of effect (t)
S31
Set CLUT unit to Use Pallet Data Specified by pallet_id_ref of effect(t)
S32
S40
t=number_of _effect(t) ?
YES
NO
RETURN
S39
t←t+1, u←0
YES
S38
NO
Effect_Duration Timer Times Out?
S37
u=number_of Composition_object ?
YES
NO
S33
effect(t). Composition_object(u).object _cropped_flag=0 ?
YES
NO
S34
Render Cropped Graphics Object as Defined by composition_object(u) into Specified Window at Specified Position According to composition_object(u)
S35
Graphics Object is Not Presented
u←u+1
S36

FIG.44

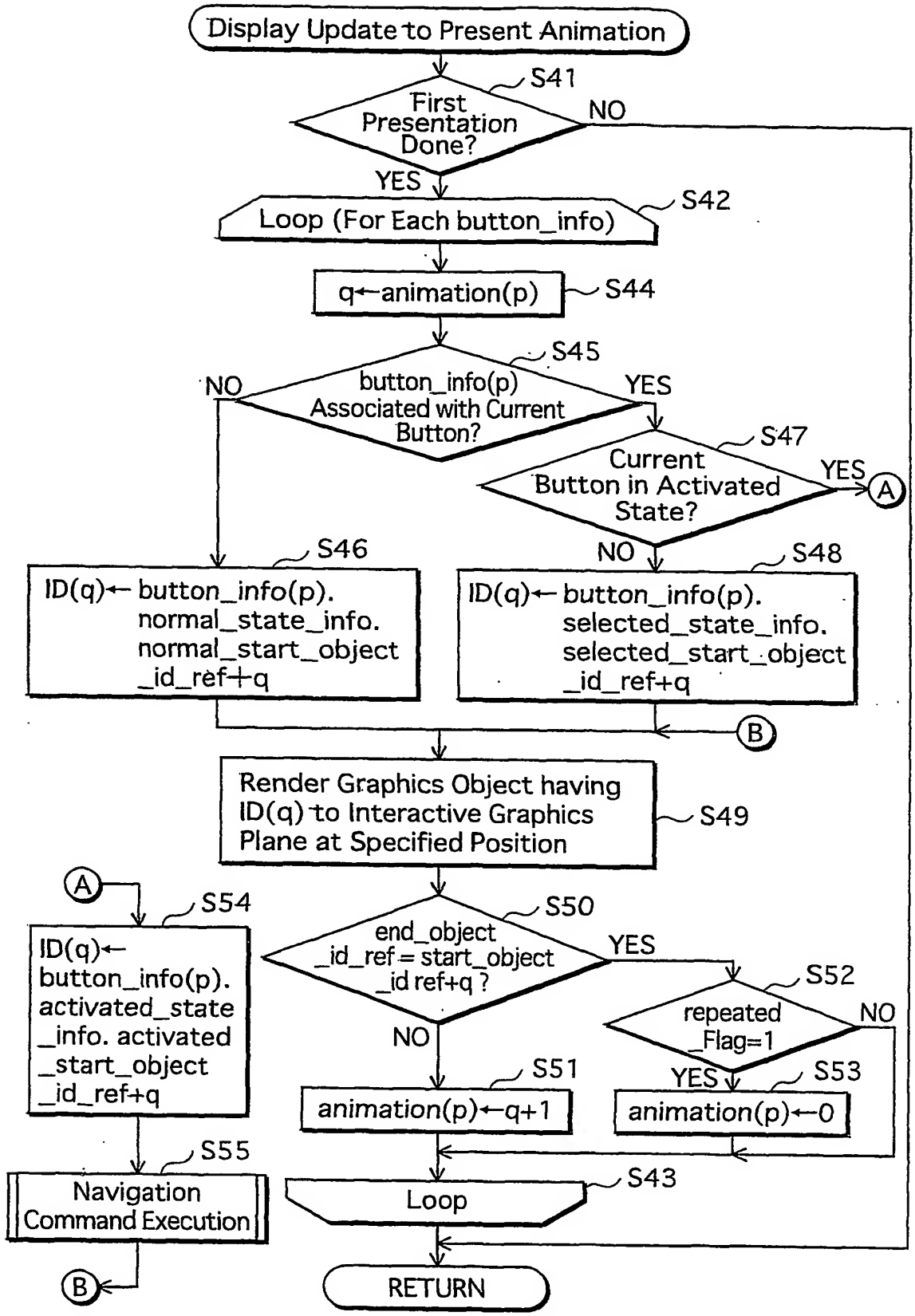

Display Update to Present Animation
S41
First Presentation Done?
NO
YES
S42
Loop (For Each button_info)
q←animation(p)
S44
S45
button_info(p) Associated with Current Button?
NO
YES
S47
Current Button in Activated State?
YES
A
NO
S46
ID(q)← button_info(p). normal_state_info. normal_start_object _id_ref+q
S48
ID(q)← button_info(p). selected_state_info. selected_start_object _id_ref+q
B
Render Graphics Object having ID(q) to Interactive Graphics Plane at Specified Position
S49
A
S54
ID(q)← button_info(p). activated_state _info. activated _start_object _id_ref+q
S50
end_object _id_ref = start_object _id ref+q ?
YES
NO
S52
repeated _Flag=1
NO
YES
S53
animation(p)←0
S51
animation(p)←q+1
S55
Navigation Command Execution
S43
Loop
B
RETURN

FIG.45

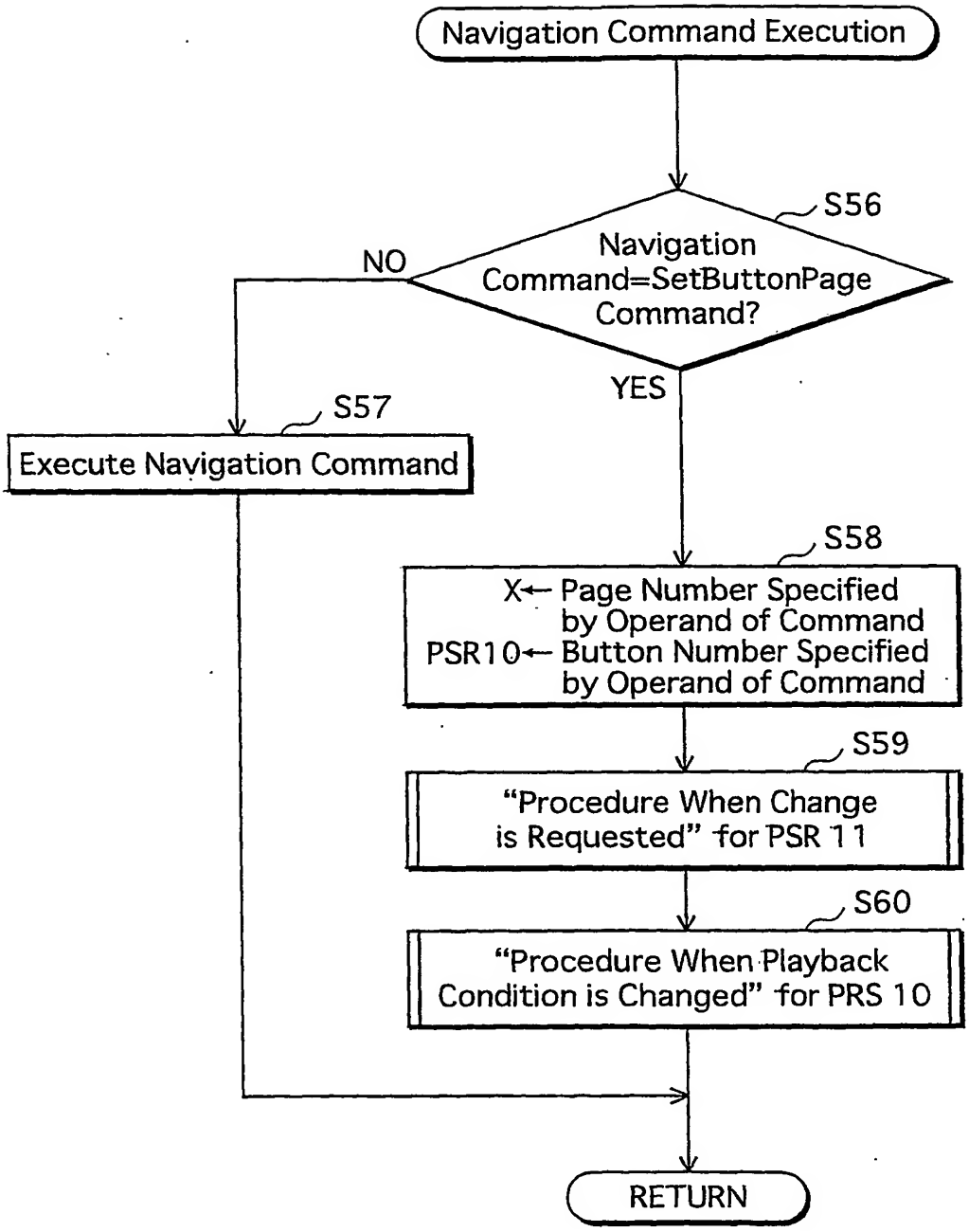

Navigation Command Execution
S56
Navigation Command=SetButtonPage Command?
NO
YES
S57
Execute Navigation Command
S58
X← Page Number Specified by Operand of Command
PSR10← Button Number Specified by Operand of Command
S59
"Procedure When Change is Requested" for PSR 11
S60
"Procedure When Playback Condition is Changed" for PRS 10
RETURN

FIG.46

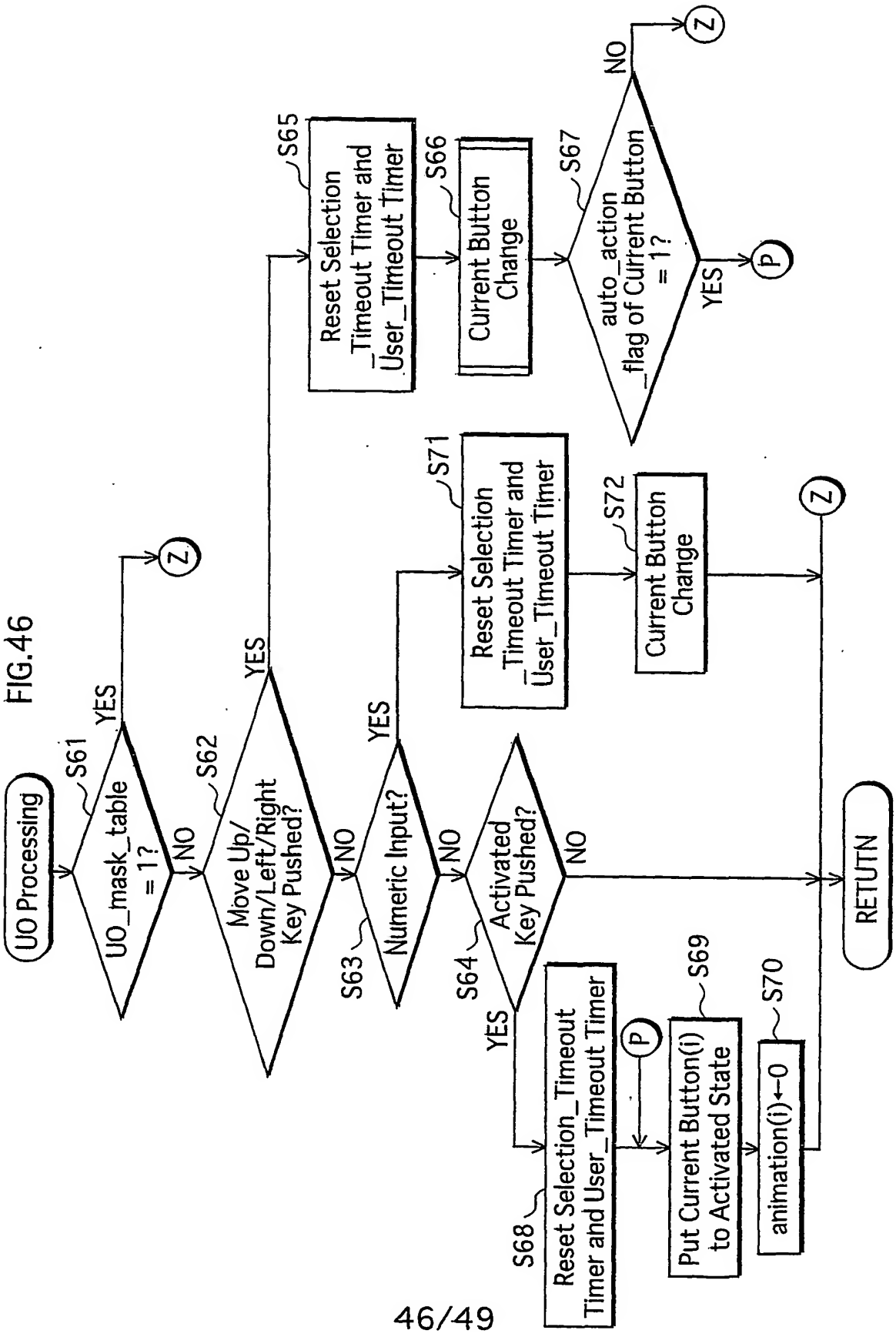

UO Processing
S61
UO_mask_table = 1?
YES
NO
Z
S62
Move Up/ Down/Left/Right Key Pushed?
YES
NO
S63
Numeric Input?
YES
NO
S64
Activated Key Pushed?
YES
NO
S65
Reset Selection _Timeout Timer and User_Timeout Timer
S66
Current Button Change
S67
auto_action _flag of Current Button = 1?
NO
YES
Z
P
S71
Reset Selection _Timeout Timer and User_Timeout Timer
S72
Current Button Change
Z
RETUTN
S68
Reset Selection_Timeout Timer and User_Timeout Timer
P
S69
Put Current Button(i) to Activated State
S70
animation(i)←0

FIG.47

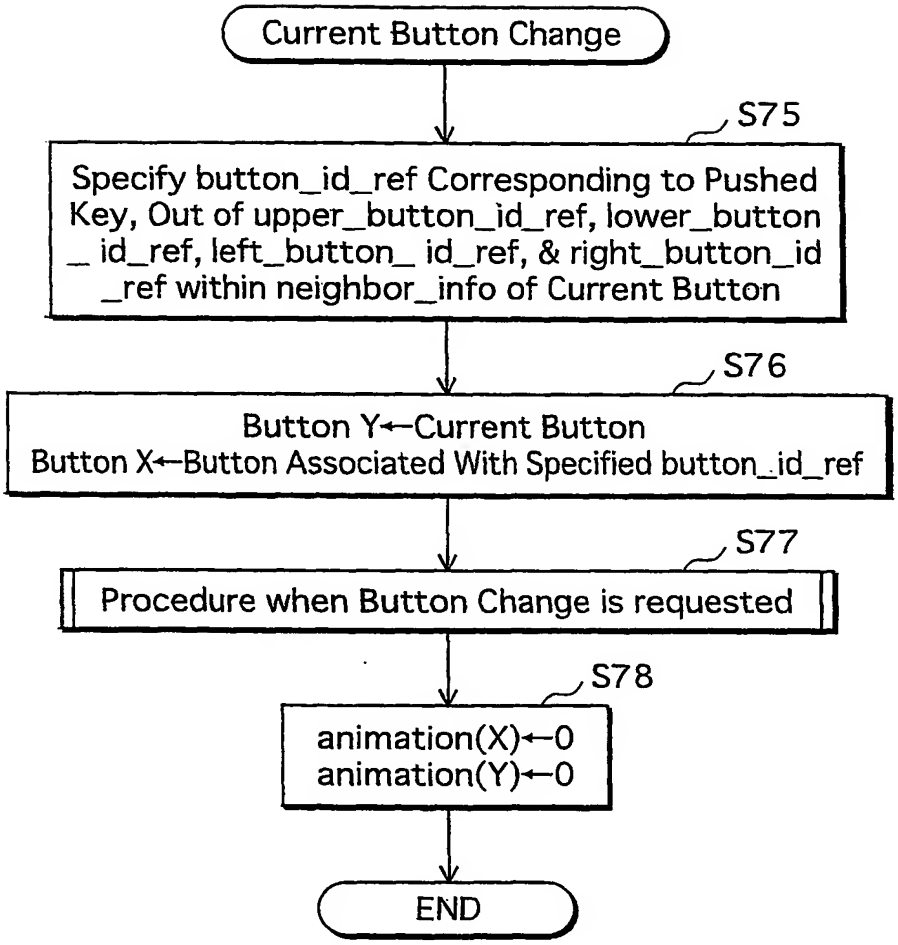
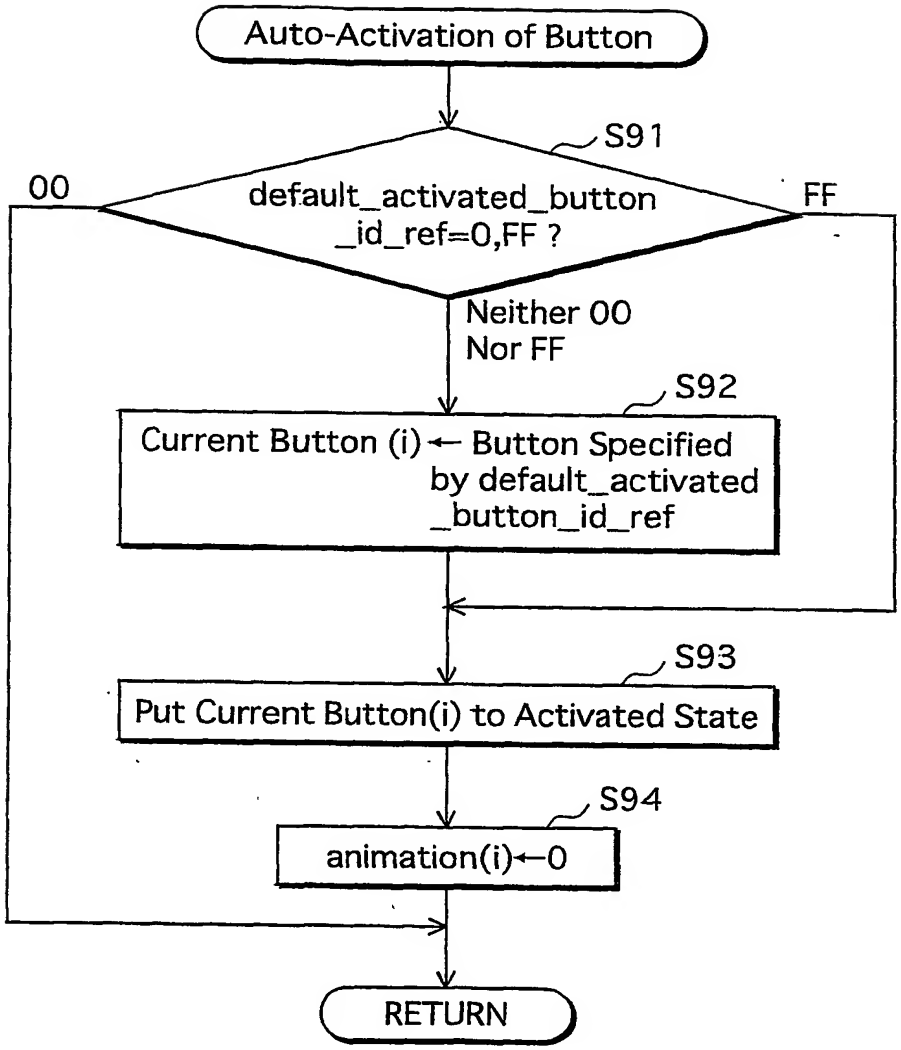

Current Button Change
S75
Specify button_id_ref Corresponding to Pushed Key, Out of upper_button_id_ref, lower_button _ id_ref, left_button_ id_ref, & right_button_id _ref within neighbor_info of Current Button
S76
Button Y←Current Button
Button X←Button Associated With Specified button_id_ref
S77
Procedure when Button Change is requested
S78
animation(X)←0
animation(Y)←0
END

FIG.48


Auto-Activation of Button
S91
default_activated_button _id_ref=0,FF ?
00
FF
Neither 00 Nor FF
S92
Current Button (i) ← Button Specified by default_activated _button_id_ref
S93
Put Current Button(i) to Activated State
S94
animation(i)←0
RETURN

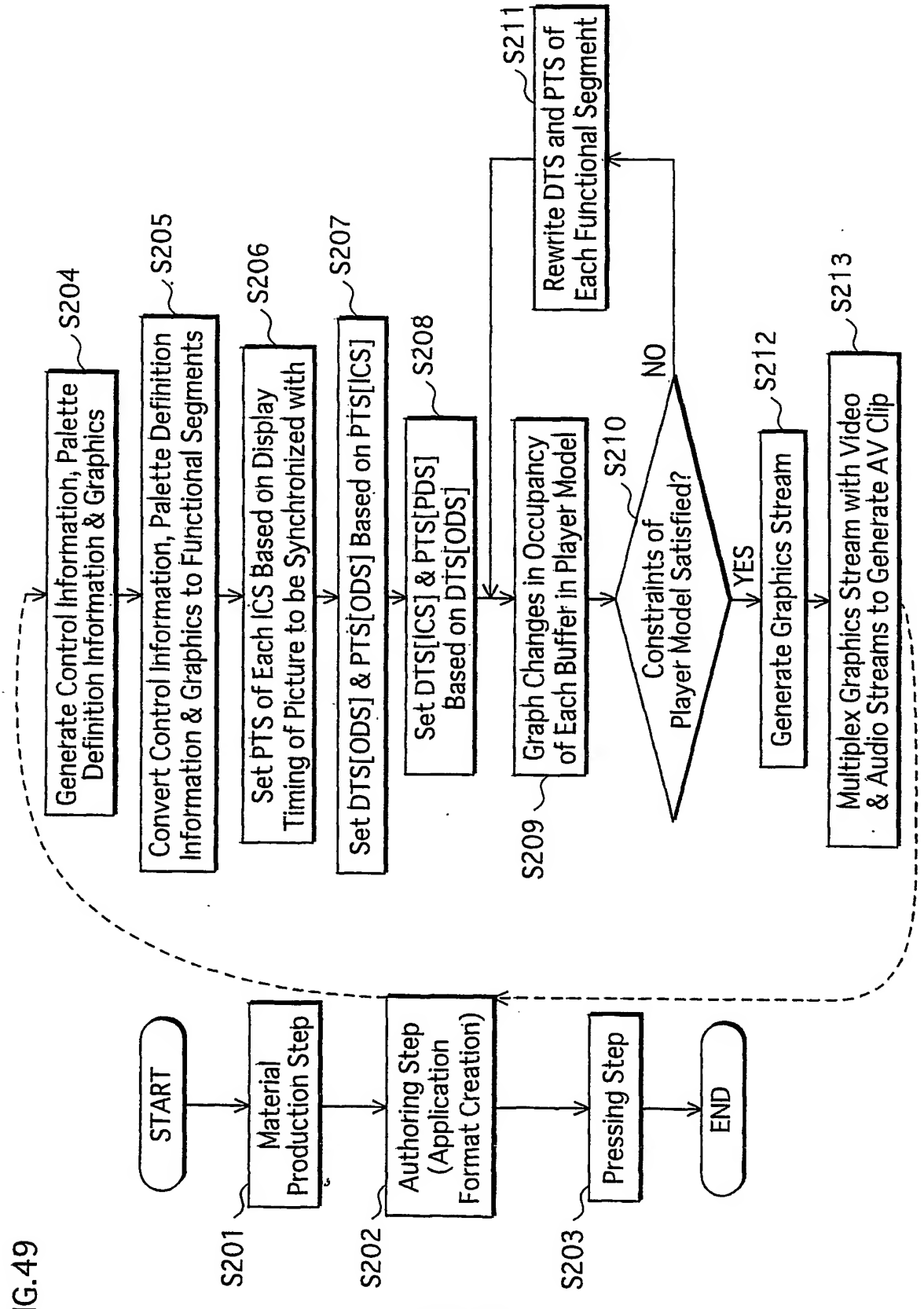

START
Material Production Step
S201
Authoring Step (Application Format Creation)
S202
Pressing Step
S203
END
Generate Control Information, Palette Definition Information & Graphics
S204
Convert Control Information, Palette Definition Information & Graphics to Functional Segments
S205
Set PTS of Each ICS Based on Display Timing of Picture to be Synchronized with
S206
Set DTS[ODS] & PTS[ODS] Based on PTS[ICS]
S207
Set DTS[ICS] & PTS[PDS] Based on DTS[ODS]
S208
Graph Changes in Occupancy of Each Buffer in Player Model
S209
Constraints of Player Model Satisfied?
S210
NO
YES
Rewrite DTS and PTS of Each Functional Segment
S211
Generate Graphics Stream
S212
Multiplex Graphics Stream with Video & Audio Streams to Generate AV Clip
S213

FIG.49